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AMOS EATON.

THE

POPULAR SCIENCE MONTHLY.

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THE ORIGIN OF MUSIC.

BY HERBERT SPENCER.

[*In preparing a final edition of my* Essays—Scientific, Political, and Speculative—*I have seized the occasion for adding a postscript to the essay on The Origin and Function of Music. As, when embodied along with other matter in its permanent form, this postscript will be seen by comparatively few, it has seemed desirable to give it a wider diffusion by publishing it separately.*]

AN opponent, or partial opponent, of high authority, whose views were published some fourteen years after the above essay, must here be answered: I mean Mr. Darwin. Diligent and careful as an observer beyond naturalists in general, and still more beyond those who are untrained in research, his judgment on a question which must be decided by induction is one to be received with great respect. I think, however, examination will show that in this instance Mr. Darwin's observations are inadequate, and his reasonings upon them inconclusive. Swayed by his doctrine of sexual selection, he has leaned toward the view that music had its origin in the expression of amatory feeling, and has been led to overestimate such evidence as he thinks favors that view, while ignoring the difficulties in its way, and the large amount of evidence supporting another view. Before considering the special reasons for dissenting from his hypothesis, let us look at the most general reasons.

The interpretation of music which Mr. Darwin gives, agrees with my own in supposing music to be developed from vocal noises; but differs in supposing a particular class of vocal noises to have originated it—the amatory class. I have aimed to show that music has its germs in the sounds which the voice emits under excitement, and eventually gains this or that character according to the kind of excitement; whereas Mr. Darwin argues that music arises from those sounds which the male makes during the excitements of courtship, that they are consciously made to charm the female, and that from the resulting combinations of sounds arise not love-music only but music in general. That certain tones of voice and cadences having some likeness of nature are spontaneously used to express grief, others to express joy, others to express affection, and others to express triumph or martial ardor, is undeniable. According to the view I have set forth, the whole body of these vocal manifestations of emotion form the root of music. According to Mr. Darwin's view, the sounds which are prompted by the amatory feeling only, having originated musical utterance, there are derived from these all the other varieties of musical utterance which aim to express other kinds of feeling. This roundabout derivation has, I think, less probability than the direct derivation.

This antithesis and its implications will perhaps be more clearly understood on looking at the facts under their nervo-muscular aspect. Mr. Darwin recognizes the truth of the doctrine with which the foregoing essay sets out, that feeling discharges itself in action: saying of the air-breathing vertebrata that—

"When the primeval members of this class were strongly excited and their muscles violently contracted, purposeless sounds would almost certainly have been produced; and these, if they proved in any way serviceable, might readily have been modified or intensified by the preservation of properly adapted variations." (*The Descent of Man*, vol. ii, p. 331.)

But though this passage recognizes the general relation between feelings and those muscular contractions which cause sounds, it does so inadequately; since it ignores, on the one hand, those loudest sounds which accompany intense sensations—the shrieks and groans of bodily agony; while, on the other hand, it ignores those multitudinous sounds not produced "under the excitement of love, rage, and jealousy," but which accompany ordinary amounts of feelings, various in their kinds. And it is because he does not bear in mind how large a proportion of vocal noises are caused by other excitements, that Mr. Darwin thinks "a strong case can be made out, that the vocal organs were primarily used and perfected in relation to the propagation of the species" (p. 330).

Certainly the animals around us yield but few facts countenancing his view. The cooing of pigeons may, indeed, be named in its support; and it may be contended that caterwauling furnishes evidence; though I doubt whether the sounds are made by the male to charm the female. But the howling of dogs has no relation to sexual excitements; nor has their barking, which is used to express emotion of almost any kind. Pigs grunt sometimes through pleasurable expectation, sometimes during the gratifications of eating, sometimes from a general content while seeking about for food. The bleatings of sheep, again, occur under the promptings of various feelings, usually of no great intensity: social and maternal rather than sexual. The like holds with the lowing of cattle. Nor is it otherwise with poultry. The quacking of ducks indicates general satisfaction, and the screams occasionally vented by a flock of geese seem rather to express a wave of social excitement than anything else. Save after laying an egg, when the sounds have the character of triumph, the cluckings of a hen show content; and on various occasions cock-crowing apparently implies good spirits only. In all cases an overflow of nervous energy has to find vent; and while in some cases it leads to wagging of the tail, in others it leads to contraction of the vocal muscles. That this relation holds, not of one kind of feeling, but of many kinds, is a truth which seems to me at variance with the view "that the vocal organs were primarily used and perfected in relation to the propagation of the species."

The hypothesis that music had its origin in the amatory sounds made by the male to charm the female, has the support of the popular idea that the singing of birds constitutes a kind of courtship—an idea adopted by Mr. Darwin when he says that "the male pours forth his full volume of song, in rivalry with other males, for the sake of captivating the female." Usually, Mr. Darwin does not accept without criticism and verification, the beliefs he finds current; but in this case he seems to have done so. Even cursory observation suffices to dissipate this belief, initiated, I suppose, by poets. In preparation for dealing with the matter I have made memoranda concerning various song-birds, dating back to 1883. On the 7th of February of that year I heard a lark singing several times; and, still more remarkably, during the mild winter of 1884 I saw one soar, and heard it sing, on the 10th January. Yet the lark does not pair till March. Having heard the redbreast near the close of August, 1888, I noted the continuance of its song all through the autumn and winter, up to Christmas eve, Christmas day, the 29th of December, and again on the 18th January, 1889. How common is the singing of the thrush during mild weather in winter, every one must have observed. The presence of thrushes behind my house has led to the making of notes on this point. The male sang in November, 1889; I noted the song again on Christmas eve, again on the 13th January, 1890, and from time to time all through the rest of that month. I heard little of his song in February, which is the pairing season; and none at all, save a few notes early in the morning, during the period of rearing the young. But now that, in the middle of May, the young, reared in a nest in my garden, have some time since flown, he has recommenced singing vociferously at intervals throughout the day; and doubtless, in conformity with what I have observed elsewhere, will go on singing till July. How marked is the direct relation between singing and the conditions which cause high spirits, is perhaps best shown by a fact I noted on the 4th December, 1888, when, the day being not only mild but bright, the copses on Holmwood Common, Dorking, were vocal just as on a spring day, with a chorus of birds of various kinds—robins, thrushes, chaffinches, linnets, and sundry others of which I did not know the names. Ornithological works furnish verifying statements. Wood states that the hedge-sparrow continues "to sing throughout a large portion of the year, and only ceasing during the time of the ordinary molt." The song of the Blackcap, he says, "is hardly suspended throughout the year;" and of caged birds which sing continuously, save when molting, he names the Grosbeak, the Linnet, the Goldfinch, and the Siskin.

I think these facts show that the popular idea adopted by Mr. Darwin is untenable. What then is the true interpretation? Simply that like the whistling and humming of tunes by boys and men, the singing of birds results from overflow of energy—an overflow which in both cases ceases under depressing conditions. The relation between courtship and singing, so far as it can be shown to hold, is not a relation of cause and effect, but a relation of concomitance: the two are simultaneous results of the same cause. Throughout the animal kingdom at large, the commencement of reproduction is associated with an excess of those absorbed materials needful for self-maintenance; and with a consequent ability to devote a part to the maintenance of the species. This constitutional state is one with which there goes a tendency to superfluous expenditure in various forms of action—unusual vivacity of every kind, including vocal vivacity. While we thus see why pairing and singing come to be associated, we also see why there is singing at other times when the feeding and weather are favorable; and why, in some cases, as in those of the thrush and the robin, there is more singing after the breeding season than before or during the breeding season. We are shown, too, why these birds, and especially the thrush, so often sing in the winter: the supply of worms on lawns and in gardens being habitually utilized by both, and thrushes having the further advantage that they are strong enough to break the shells of the hibernating snails: this last ability being connected with the fact that thrushes and blackbirds are the first among the singing birds to build. It remains only to add that the alleged singing of males against one another with the view of charming the females is open to parallel criticisms. How far this competition happens during the pairing season I have not observed, but it certainly happens out of the pairing season. I have several times heard blackbirds singing alternately in June. But the most conspicuous instance is supplied by the redbreasts. These habitually sing against one another during the autumn months: reply and rejoinder being commonly continued for five minutes at a time.

Even did the evidence support the popular view adopted by Mr. Darwin, that the singing of birds is a kind of courtship—even were there good proof, instead of much disproof, that a bird's song is a developed form of the sexual sounds made by the male to charm the female; the conclusion would, I think, do little toward justifying the belief that human music has had a kindred origin. For, in the first place, the bird-type in general, developed as it is out of the reptilian type, is very remotely related to that type of the *Vertebrata* which ascends to Man as its highest exemplar; and, in the second place, song-birds belong, with but few exceptions, to the single order of *Insessores*—one order only, of the many orders constituting the class. So that, if the *Vertebrata* at large be represented by a tree, of which Man is the topmost twig, then it is at a considerable distance down the trunk that there diverges the branch from which the bird-type is derived; and the group of singing-birds forms but a terminal subdivision of this branch—lies far out of the ascending line which ends in Man. To give appreciable support to Mr. Darwin's view, we ought to find vocal manifestations of the amatory feeling becoming more pronounced as we ascend along that particular line of inferior *Vertebrata* out of which Man has arisen. Just as we find other traits which pre-figure human traits (instance arms and hands adapted for grasping) becoming more marked as we approach Man; so should we find, becoming more marked, this sexual use of the voice, which is supposed to end in human song. But we do not find this. The South American monkeys ("the Howlers," as they are sometimes called), which, in chorus, make the woods resound for hours together with their "dreadful concert," appear, according to Rengger, to be prompted by no other desire than that of making a noise. Mr. Darwin admits, too, that this is generally the case with the gibbons: the only exception he is inclined to make being in the case of *Hylobates agilis*, which, on the testimony of Mr. Waterhouse, he says ascends and descends the scale by half-tones.* This comparatively musical set of sounds, he thinks, may be used

* It is far more probable that the ascents and descents made by this gibbon consisted of indefinitely-slurred tones. To suppose that each was a series of definite semi-tones strains belief to breaking point; considering that among human beings the great majority, even of those who have good ears, are unable to go up or down the chromatic scale without being taught to do so. The achievement is one requiring considerable practice; and that such an achievement should be spontaneous on the part of a monkey is incredible.

to charm the female; though there is no evidence forthcoming that this is the case. When we remember that in the forms nearest to the human—the chimpanzees and the gorilla—there is nothing which approaches even thus far toward musical utterance, we see that the hypothesis has next to none of that support which ought to be forthcoming. Indeed in his *Descent of Man*, vol. ii, p. 332, Mr. Darwin himself says:—"It is a surprising fact that we have not as yet any good evidence that these organs are used by male mammals to charm the female:" an admission which amounts to something like a surrender.

Even more marked is the absence of proof when we come to the human race itself—or rather, not absence of proof but presence of disproof. Here, from the *Descriptive Sociology*, where the authorities will be found under the respective heads, I quote a number of testimonies of travelers concerning primitive music; commencing with those referring to the lowest race.

"The songs of the natives [of Australia] . . . are chiefly made on the spur of the moment, and refer to something that has struck the attention at the time." "The Watchandies seeing me much interested in the genus Eucalyptus soon composed a song on this subject." The Fuegians are fond of music and generally sing in their boats, doubtless keeping time, as many primitive peoples do. "The principal subject of the songs of the Araucanians is the exploits of their heroes:" when at work their "song was simple, referring mostly to their labor," and was the same "for every occasion, whether the burden of the song be joy or sorrow." The Greenlanders sing of "their exploits in the chase" and "chant the deeds of their ancestors." The Indians of the Upper Mississippi vocalize an incident, as—'They have brought us a fat dog':" then the chorus goes on for a minute. Of other North-American Indians we read—"the air which the women sang was pleasing . . . the men first gave out the words, which formed a consummate glorification of themselves." Among the Carriers (of North America) there are professed composers, who "turn their talent to good account on the occasion of a feast, when new airs are in great request." Of the New Zealanders we read:—"The singing of such compositions [laments] resembles cathedral chanting." "Passing events are described by extemporaneous songs, which are preserved when good." "When men worked together appropriate airs were sung." When presenting a meal to travelers, women would chant—"What shall be our food? shell fish and fern-root, that is the root of the earth." Among the Sandwich Islanders "most of the traditions of remarkable events in their history are preserved in songs." When taught reading they could not "recite a lesson without chanting or singing it." Cook found the Tahitians had itinerant musicians who gave narrative chants quite unpremeditated. "A Samoan can hardly put his paddle in the water without striking up some chant." A chief of the Kyans, "Tamawan, jumped up and while standing burst out into an extempore song, in which Sir James Brooke and myself, and last not least the wonderful steamer, was mentioned with warm eulogies." In East Africa "the fisherman will accompany his paddle, the porter his trudge, and the housewife her task of rubbing down grain, with song." In singing, the East African "contents himself with improvising a few words without sense or rhyme and repeats them till they nauseate." Among the Dahomans any incident "from the arrival of a stranger to an earthquake" is turned into a song. When rowing, the Coast-negroes sing "either a description of some love intrigue or the praise of some woman celebrated for her beauty." In Loango "the women as they till the field make it echo with their rustic songs." Park says of the Bambarran—"they lightened their labors by songs, one of which was composed extempore; for I was myself the subject of it." "In some parts of Africa nothing is done except to the sound of music." "They are very expert in adapting the subjects of these songs to current events." The Malays "amuse all their leisure hours . . . with the repetition of songs, which are for the most part proverbs illustrated. . . . Some that they rehearse in a kind of recitative at their *bimbangs* or feasts are historical love-tales." A Sumatran maiden will sometimes begin a tender song and be answered by one of the young men. The ballads of the Kamtschadales are "inspired apparently by grief, love, or domestic feeling;" and their music conveys "a sensation of sorrow and vague, unavailing regret." Of their long-songs it is said "the women generally compose them." A Kirghiz "singer sits on one knee and sings in an unnatural tone of voice, his lay being usually of an amorous character." Of the Yakuts we are told "their style of singing is monotonous . . . their songs described the beauty of the landscape in terms which appeared to me exaggerated."

In these statements, which, omitting repetitions, are all which the *Descriptive Sociology* contains relevant to the issue, several striking facts are manifest. Among the lowest races the only musical utterances named are those which refer to the incidents of the moment, and seem prompted by feelings which those incidents produce. The derivation of song or chant from emotional speech in general, thus suggested, is similarly suggested by the habits of many higher races; for they, too, show us that the musically-expressed feelings relevant to the immediate occasion, or to past occasions, are feelings of various kinds: now of simple good spirits and now of joy or triumph—now of surprise, praise, admiration, and now of sorrow, melancholy, regret. Only among certain of the more advanced races, as the semi-civilized Malays and peoples of Northern Asia, do we read of love-songs; and then, strange to say, these are mentioned as mostly coming, not from men, but from women. Out of all the testimonies there is not one which tells of a love-song spontaneously commenced by a man to charm a woman. Entirely absent among the rudest types and many of the more developed types, amatory musical utterance, where first found, is found under a form opposite to that which Mr. Darwin's hypothesis implies; and we have to seek among civilized peoples before we meet, in serenades and the like, music of the kind which, according to his view, should be the earliest.*

Even were his view countenanced by the facts, there would remain unexplained the process by which sexually-excited sounds have been evolved into music. In the foregoing essay I have indicated the various qualities, relations, and combinations of tones, spontaneously prompted by emotions of all kinds, which exhibit, in undeveloped forms, the traits of recitative and melody. To have reduced his hypothesis to a shape admitting of comparison, Mr. Darwin should have shown that the sounds excited by sexual emotions possess these same traits; and, to have proved that his hypothesis is the more tenable, should have shown that they possess these same traits in a greater degree. But he has not attempted to do this. He has simply suggested that instead of having its roots in the vocal sounds caused by feelings of all kinds, music has its roots in the vocal sounds caused by the amatory feeling only: giving no reason why the effects of the feelings at large should be ignored, and the effects of one particular feeling alone recognized.

Nineteen years after my essay on "The Origin and Function of Music" was published, Mr. Edmund Gurney criticised it in an article which made its appearance in the *Fortnightly Review* for July, 1876. Absorption in more important work prevented me from replying. Though, some ten years ago, I thought of defending my views against those of Mr. Darwin and Mr. Gurney, the occurrence of Mr. Darwin's death obliged me to postpone for a time any discussion of his views; and then, the more recent unfortunate death of Mr. Gurney caused a further postponement. I must now, however, say that which seems needful, though there is no longer any possibility of a rejoinder from him.

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* After the above paragraphs had been sent to the printers I received from an American anthropologist, the Rev. Owen Dorsey, some essays containing kindred evidence. Of over three dozen songs and chants of the Omaha, Ponka, and other Indians, in some cases given with music and in other cases without, there are but five which have any reference to amatory feeling; and while in these the expression of amatory feeling comes from women, nothing more than derision of them comes from men.

Some parts of Mr. Gurney's criticism I have already answered by implication; for he adopts the hypothesis that music originated in the vocal utterances prompted by sexual feeling. To the reasons above given for rejecting this hypothesis, I will add here, what I might have added above, that it is at variance with one of the fundamental laws of evolution. All development proceeds from the general to the special. First there appear those traits which a thing has in common with many other things; then those traits which it has in common with a smaller class of things; and so on until there eventually arise those traits which distinguish it from everything else. The genesis which I have described conforms to this fundamental law. It posits the antecedent fact that feeling in general produces muscular contraction in general; and the less general fact that feeling in general produces, among other muscular contractions, those which move the respiratory and vocal apparatus. With these it joins the still less general fact that sounds indicative of feelings vary in sundry respects according to the intensity of the feelings; and then enumerates the still less general facts which show us the kinship between the vocal manifestations of feeling and the characters of vocal music: the implication being that there has gone on a progressive specialization. But the view which Mr. Gurney adopts from Mr. Darwin is that from the special actions producing the special sounds accompanying sexual excitement, were evolved those various actions producing the various sounds which accompany all other feelings. Vocal expression of a particular emotion came first, and from this proceeded vocal expressions of emotions in general: the order of evolution was reversed.

To deficient knowledge of the laws of evolution are due sundry of Mr. Gurney's objections. He makes a cardinal error in assuming that a more evolved thing is distinguished from less evolved things in respect of *all* the various traits of evolution; whereas, very generally, a higher degree of evolution in some or most respects, is accompanied by an equal or lower degree of evolution in other respects. On the average, increase of locomotive power goes along with advance of evolution; and yet numerous mammals are more fleet than man. The stage of development is largely indicated by degree of intelligence; and yet the more intelligent parrot is inferior in vision, in speed, and in destructive appliances, to the less-intelligent hawk. The contrast between birds and mammals well illustrates the general truth. A bird's skeleton diverges more widely from the skeleton of the lower vertebrates in respect of heterogeneity than does the skeleton of a mammal; and the bird has a more developed respiratory system, as well as a higher temperature of blood, and a superior power of locomotion. Nevertheless, many mammals in respect of bulk, in respect of various appliances (especially for prehension), and in respect of intelligence, are more evolved than birds. Thus it is obviously a mistake to assume that whatever is more highly evolved in general character is more highly evolved in every trait.

Of Mr. Gurney's several objections which are based on this mistake here is an example. He says—"Loudness though a frequent is by no means a universal or essential element, either of song or of emotional speech" (p. 107). Under one of its aspects this criticism is self-destructive; for if, though both relatively loud in most cases, song and emotional speech are both characterized by the occasional use of subdued tones, then this is a further point of kinship between them—a kinship which Mr. Gurney seeks to disprove. Under its other aspect this criticism implies the above-described misconception. If in a song, or rather in some part or parts of a song, the trait of loudness is absent, while the other traits of developed emotional utterance are present, it simply illustrates the truth that the traits of a highly-evolved product are frequently not all present together.

A like answer is at hand to the next objection he makes. It runs thus:—

"In the recitative which he [Mr. Spencer] himself considers naturally and historically a step between speech and song, the rapid variation of pitch is impossible, and such recitative is distinguished from the tones even of common speech precisely by being more monotonous" (p. 108).

But Mr. Gurney overlooks the fact that while, in recitative, some traits of developed emotional utterance are not present, two of its traits are present. One is that greater resonance of tone, caused by greater contraction of the vocal chords, which distinguishes it from ordinary speech. The other is the relative elevation of pitch, or divergence from the medium tones of voice: a trait similarly implying greater strain of certain vocal muscles, resulting from stronger feeling.

Another difficulty raised by Mr. Gurney he would probably not have set down had he been aware that one character of musical utterance which he thinks distinctive, is a character of all phenomena into which motion enters as a factor. He says:— "Now no one can suppose that the sense of rhythm can be derived from emotional speech" (p. 110). Had he referred to the chapter on "The Rhythm of Motion" in *First Principles*, he would have seen that, in common with inorganic actions, all organic actions are completely or partially rhythmical—from appetite and sleep to inspirations and heart-beats; from the winking of the eyes to the contractions of the intestines; from the motions of the legs to discharges through the nerves. Having contemplated such facts he would have seen that the rhythmical tendency which is perfectly displayed in musical utterance, is imperfectly displayed in emotional speech. Just as under emotion we see swayings of the body and wringings of the hands, so do we see contractions of the vocal organs which are now stronger and now weaker. Surely it is manifest that the utterances of passion, far from being monotonous, are characterized by rapidly-recurring ascents and descents of tone and by rapidly-recurring emphases: there is rhythm, though it is an irregular rhythm.

Want of knowledge of the principles of evolution has, in another place, led Mr. Gurney to represent as an objection what is in reality a verification. He says:—

"Music is distinguished from emotional speech in that it proceeds not only by fixed degrees in time, but by fixed degrees in the scale. This is a constant quality through all the immense quantity of embryo and developed scale-systems that have been used: whereas the transitions of pitch which mark emotional affections of voice are, as Helmholtz has pointed out, of a gliding character" (p. 113).

Had Mr. Gurney known that evolution in all cases is from the indefinite to the definite, he would have seen that as a matter of course the gradations of emotional speech must be indefinite in comparison with the gradations of developed music. Progress from the one to the other is in part *constituted* by increasing definiteness in the time-intervals and increasing definiteness in the tone-intervals. Were it otherwise, the hypothesis I have set forth would lack one of its evidences. To his allegation that not only the "developed scale-systems" but also the "embryo" scale-systems are definite, it may obviously be replied that the mere existence of any scale-system capable of being written down, implies that the earlier stage of the progress has already been passed through. To have risen to a scale-system is to have become definite; and until a scale-system has been reached vocal phrases can not have been recorded. Moreover had Mr. Gurney remembered that there are many people with musical perceptions so imperfect that when making their merely recognizable, and sometimes hardly recognizable, attempts to whistle or hum melodies, they show how vague are their appreciations of musical intervals, he would have seen reason for doubting his assumption that definite scales were reached all at once. The fact that in what we call bad ears there are all degrees of imperfection, joined with the fact that where the imperfection is not great practice may remedy it, suffice of themselves to show that definite perceptions of musical intervals were reached by degrees.

Some of Mr. Gurney's objections are strangely insubstantial. Here is an example:—

"The fact is that song, which moreover in our time is but a limited branch of music, is perpetually making conscious efforts; for instance, the most peaceful melody may be a considerable strain to a soprano voice, if sung in a very high register: while speech continues to obey in a natural way the physiological laws of emotion" (p. 117.)

That in exaggerating and emphasizing the traits of emotional speech, the singer should be led to make "conscious efforts" is surely natural enough. What would Mr. Gurney have said of dancing? He would scarcely have denied that saltatory movements often result spontaneously from excited feeling; and he could hardly have doubted that primitive dancing arose as a systematized form of such movements. Would he have considered the belief that stage-dancing is evolved from these spontaneous movements to be negatived by the fact that a stage-dancer's bounds and gyrations are made with "conscious efforts"?

In his elaborate work on *The Power of Sound*, Mr. Gurney, repeating in other forms the objections I have above dealt with, adds to them some others. One of these, which appears at first sight to have much weight, I must not pass by. He thus expresses it:—

"Any one may convince himself that not only are the intervals used in emotional speech very large, twelve diatonic notes being quite an ordinary skip, but that he uses extremes of both high and low pitch with his speaking voice, which, if he tries to dwell on them and make them resonant, will be found to lie beyond the compass of his singing voice" (p. 479).

Now the part of my hypothesis which Mr. Gurney here combats is that, as in emotional speech so in song, feeling, by causing muscular contractions, causes divergences from the middle tones of the voice, which become wider as it increases; and that this fact supports the belief that song is developed from emotional speech. To this Mr. Gurney thinks it a conclusive answer that higher notes are used by the speaking voice than by the singing voice. But if, as his words imply, there is a physical impediment to the production of notes in the one voice as high as those in the other, then my argument is justified if, in either voice, extremes of feeling are shown by extremes of pitch. If, for example, the celebrated *ut de poitrine* with which Tamberlik brought down the house in one of the scenes of William Tell, was recognized as expressing the greatest intensity of martial patriotism, my position is warranted, even though in his speaking voice he could have produced a still higher note.

Of answers to Mr. Gurney's objections the two most effective are suggested by the passage in which he sums up his conclusions. Here are his words:

"It is enough to recall how every consideration tended to the same result; that the oak grew from the acorn; that the musical faculty and pleasure, which have to do with music and nothing else, are the representatives and linear descendants of a faculty and pleasure which were musical and nothing else; and that, however rudely and tentatively applied to speech, Music was a *separate order*" (p. 492).

Thus, then, it is implied that the true germs of music stand toward developed music as the acorn to the oak. Now suppose we ask—How many traits of the oak are to be found in the acorn? Next to none. And then suppose we ask—How many traits of music are to be found in the tones of emotional speech? Very many. Yet while Mr. Gurney thinks that music had its origin in something which might have been as unlike it as the acorn is unlike the oak, he rejects the theory that it had its origin in something as much like it as the cadences of emotional speech; and he does this because there are sundry differences between the characters of speech-cadences and the characters of music. In the one case he tacitly assumes a great unlikeness between germ and product; while in the other case he objects because germ and product are not in all respects similar!

I may end by pointing out how extremely improbable, *a priori*, is Mr. Gurney's conception. He admits, as perforce he must, that emotional speech has various traits in common with recitative and song—relatively greater resonance, relatively greater loudness, more marked divergences from medium tones, the use of the extremes of pitch in signifying the extremes of feeling, and so on. But, denying that the one is derived from the others, he implies that these kindred groups of traits have had independent origins. Two sets of peculiarities in the use of the voice which show various kinships, have nothing to do with one another! I think it merely requires to put the proposition in this shape to see how incredible it is.

Sundry objections to the views contained in the essay on "The Origin and Function of Music," have arisen from misconception of its scope. An endeavor to explain the *origin* of music, has been dealt with as though it were a theory of music in its entirety. An hypothesis concerning the rudiments has been rejected because it did not account for everything contained in the developed product. To preclude this misapprehension for the future, and to show how much more is comprehended in a theory of music than I professed to deal with, let me enumerate the several components of musical effect. They may properly be divided into *sensational*, *perceptional*, and *emotional*.

That the sensational pleasure is distinguishable from the other pleasures which music yields, will not be questioned. A sweet sound is agreeable in itself, when heard out of relation to other sounds. Tones of various *timbres*, too, are severally appreciated as having their special beauties. Of further elements in the sensational pleasure have to be named those which result from certain congruities between notes and immediately succeeding notes. This pleasure, like the primary pleasure which fine quality yields, appears to have a purely physical basis. We know that the agreeableness of simultaneous tones depends partly on the relative frequency of recurring correspondences of the vibrations producing them, and partly on the relative infrequency of beats, and we may suspect that there is a kindred cause for the agreeableness of successive tones; since the auditory apparatus which has been at one instant vibrating in a particular manner, will take up certain succeeding vibrations more readily than others. Evidently it is a question of the *degree* of congruity; for the most congruous vibrations, those of the octaves, yield less pleasure when heard in succession than those of which the congruity is not so great. To obtain the greatest pleasure in this and other things, there requires both likeness and difference. Recognition of this fact introduces us to the next element of sensational pleasure—that due to contrast; including contrast of pitch, of loudness, and of *timbre*. In this case, as in other cases, the disagreeableness caused by frequent repetition of the same sensation (here literally called "monotony") results from the exhaustion which any single nervous agent undergoes from perpetual stimulation; and contrast gives pleasure because it implies action of an agent which has had rest. It follows that much of the sensational pleasure to be obtained from music depends on such adjustments of sounds as bring into play, without conflict, many nervous elements: exercising all and not overexerting any. We must not overlook a concomitant effect. With the agreeable sensation is joined a faint emotion of an agreeable kind. Beyond the simple definite pleasure yielded by a sweet tone, there is a vague, diffused pleasure. As indicated in the *Principles of Psychology*, § 537, each nervous excitation produces reverberation throughout the nervous system at large; and probably this indefinite emotional pleasure is a consequence. Doubtless some shape is given to it by association. But after observing how much there is in common between the diffused feeling aroused by smelling a deliciously scented flower and that aroused by listening to a sweet tone, it will, I think, be perceived that the more general cause predominates.

The division between the sensational effects and the perceptional effects is of course indefinite. As above implied, part of the sensational pleasure depends on the relation between each tone and the succeeding tones; and hence this pleasure gradually merges into that which arises from perceiving the structural connections between the phrases and between the larger parts of musical compositions. Much of the gratification given by a melody consists in the consciousness of the relations between each group of sounds heard and the groups of sounds held in memory as having just passed, as well as those represented as about to come. In many cases the passage listened to would not be regarded as having any beauty were it not for its remembered connections with passages in the immediate past and the immediate future. If, for example, from the first movement of Beethoven's Funeral-March sonata the first five notes are detached, they appear to be meaningless; but if, the movement being known, they are joined with imaginations of the anticipated phrases, they immediately acquire meaning and beauty. Indefinable as are the causes of this perceptional pleasure in many cases, some causes of it are definable. Symmetry is one. A chief element in melodic effect results from repetitions of phrases which are either identical, or differ only in pitch, or differ only in minor variations: there being in the first case the pleasure derived from perception of complete likeness, and in the other cases the greater pleasure derived from perception of likeness with difference—a perception which is more involved, and therefore exercises a greater number of nervous agents. Next comes, as a source of gratification, the consciousness of pronounced unlikeness or contrast; such as that between passages above the middle tones and passages below, or as that between ascending phrases and descending phrases. And then we rise to larger contrasts; as when, the first theme in a melody having been elaborated, there is introduced another having a certain kinship though in many respects different, after which there is a return to the first theme: a structure which yields more extensive and more complex perceptions of both differences and likenesses. But while perceptional pleasures include much that is of the highest, they also include much that is of the lowest. A certain kind of interest, if not of beauty, is producible by the likenesses and contrasts of musical phrases which are intrinsically meaningless or even ugly. A familiar experience exemplifies this. If a piece of paper is folded and on one side of the crease there is drawn an irregular line in ink, which, by closing the paper, is blotted on the opposite side of the crease, there results a figure which, in virtue of its symmetry, has some beauty; no matter how entirely without beauty the two lines themselves may be. Similarly, some interest results from the parallelism of musical phrases, notwithstanding utter lack of interest in the phrases themselves. The kind of interest resulting from such parallelisms, and from many contrasts, irrespective of any intrinsic worth in their components, is that which is most appreciated by the musically-uncultured, and gives popularity to miserable drawing-room ballads and vulgar music-hall songs.

The remaining element of musical effect consists in the idealized rendering of emotion. This, as I have sought to show, is the primitive element, and will ever continue to be the vital element; for if "melody is the soul of music," then expression is the soul of melody—the soul without which it is mechanical and meaningless, whatever may be the merit of its form. This primitive element may with tolerable clearness be distinguished from the other elements, and may coexist with them in various degrees: in some cases being the predominant element. Any one who, in analytical mood, listens to such a song as *Robert, toi que j'aime*, can not, I think, fail to perceive that its effectiveness depends on the way in which it exalts and intensifies the traits of passionate utterance. No doubt as music develops, the emotional element (which affects structure chiefly through the forms of phrases) is increasingly complicated with, and obscured by, the perceptional element; which both modifies these phrases and unites them into symmetrical and contrasted combinations. But though the groups of notes which emotion prompts admit of elaboration into structures that have additional charms due to artfully-arranged contrasts and repetitions, the essential element is liable to be thus submerged in the non-essential. Only in melodies of high types, such as the *Addio* of Mozart and *Adelaide* of Beethoven, do we see the two requirements simultaneously fulfilled. Musical genius is shown in achieving the decorative beauty without losing the beauty of emotional meaning.

It goes without saying that there must be otherwise accounted for that relatively modern element in musical effect which has now almost outgrown in importance the other elements—I mean harmony. This can not be affiliated on the natural language of emotion; since, in such language, limited to successive tones, there can not originate the effects wrought by simultaneous tones. Dependent as harmony is on relations among rates of aërial pulses, its primary basis is purely mechanical; and its secondary basis lies in the compound vibrations which certain combinations of mechanical rhythms cause in the auditory apparatus. The resulting pleasure must, therefore, be due to nervous excitations of kinds which, by their congruity, exalt one another; and thus generate a larger volume of agreeable sensation. A further pleasure of sensational origin which harmony yields is due to contrapuntal effects. Skillful counterpoint has the general character that it does not repeat in immediate succession similar combinations of tones and similar directions of change; and by thus avoiding temporary overtax of the nervous structures brought into action, keeps them in better condition for subsequent action. Absence of regard for this requirement characterizes the music of Gluck, of whom Handel said—"He knows no more counterpoint than my cook;" and it is this disregard which produces its cloying character. Respecting the effects of harmony I will add only that the vague emotional accompaniment to the sensation produced by a single sweet tone, is paralleled by the stronger emotional accompaniment to the more voluminous and complex sensation produced by a fine chord. Clearly this vague emotion forms a large component in the pleasure which harmony gives.

While thus recognizing, and indeed emphasizing, the fact that of many traits of developed music my hypothesis respecting the origin of music yields no explanation, let me point out that this hypothesis gains a further general support from its conformity to the law of evolution. Progressive integration is seen in the immense contrast between the small combinations of tones constituting a cadence of grief, or anger, or triumph, and the vast combinations of tones, simultaneous and successive, constituting an oratorio. Great advance in coherence becomes manifest when, from the lax unions among the sounds in which feeling spontaneously expresses itself, or even from those few musical phrases which constitute a simple air, we pass to those elaborate compositions in which portions small and large are tied together into extended organic wholes. On comparing the unpremeditated inflexions of the voice in emotional speech, vague in tones and times, with those premeditated ones which the musician arranges for stage or concert-room, in which the divisions of time are exactly measured, the successive intervals precise, and the harmonies adjusted to a nicety, we observe in the last a far higher definiteness. And immense progress in heterogeneity is seen on putting side by side the monotonous chants of savages with the musical compositions familiar to us; each of which is relatively heterogeneous within itself, and the assemblage of which forms an immeasurably heterogeneous aggregate.

Strong support for the theory enunciated in this essay, and defended in the foregoing paragraphs, is furnished by the testimonies of two travelers in Hungary, given in works published in 1878 and 1888 respectively. Here is an extract from the first of the two:—

"Music is an instinct with these Hungarian gypsies. They play by ear, and with a marvelous precision, not surpassed by musicians who have been subject to the most careful training. . . . The airs they play are most frequently compositions of their own, and are in character quite peculiar. . . . I heard on this occasion one of the gypsy airs which made an indelible impression on my mind; it seemed to me the thrilling utterance of a people's history. There was the low wail of sorrow, of troubled passionate grief, stirring the heart to restlessness, then the sense of turmoil and defeat; but upon this breaks suddenly a wild burst of exultation, of rapturous joy—a triumph achieved, which hurries you along with it in resistless sympathy. The excitable Hungarians can literally become intoxicated with this music—and no wonder. You can not reason upon it, or explain it, but its strains compel you to sensations of despair and joy, of exultation and excitement, as though under the influence of some potent charm."—*Round about the Carpathians*, by Andrew F. Crosse, pp. 11, 12.

Still more graphic and startling is the description given by a more recent traveler, E. Gerard:—

"Devoid of printed notes, the Tzigane is not forced to divide his attention between a sheet of paper and his instrument, and there is consequently nothing to detract from the utter abandonment with which he absorbs himself in his playing. He seems to be sunk in an inner world of his own; the instrument sobs and moans in his hands, and is pressed tight against his heart as though it had grown and taken root there. This is the true moment of inspiration, to which he rarely gives way, and then only in the privacy of an intimate circle, never before a numerous and unsympathetic audience. Himself spell-bound by the power of the tones he evokes, his head gradually sinking lower and lower over the instrument, the body bent forward in an attitude of rapt attention, and his ear seeming to hearken to far-off ghostly strains audible to himself alone, the untaught Tzigane achieves a perfection of expression unattainable by mere professional training.

"This power of identification with his music is the real secret of the Tzigane's influence over his audience. Inspired and carried away by his own strains, he must perforce carry his hearers with him as well; and the Hungarian listener throws himself heart and soul into this species of musical intoxication, which to him is the greatest delight on earth. There is a proverb which says, 'The Hungarian only requires a gypsy fiddler and a glass of water in order to make him quite drunk;' and, indeed, intoxication is the only word fittingly to describe the state of exaltation into which I have seen a Hungarian audience thrown by a gypsy band.

"Sometimes, under the combined influence of music and wine, the Tziganes become like creatures possessed; the wild cries and stamps of an equally excited audience only stimulate them to greater exertions. The whole atmosphere seems tossed by billows of passionate harmony; we seem to catch sight of the electric sparks of inspiration flying through the air. It is then that the Tzigane player gives forth everything that is secretly lurking within him—fierce anger, childish wailings, presumptuous exaltation, brooding melancholy, and passionate despair; and at such moments, as a Hungarian writer has said, one could readily believe in his power of drawing down the angels from heaven into hell!

"Listen how another Hungarian has here described the effect of their music:—'How it rushes through the veins like electric fire! How it penetrates straight to the soul! In soft plaintive minor tones the *adagio* opens with a slow rhythmical movement: it is a sighing and longing of unsatisfied aspirations; a craving for undiscovered happiness; the lover's yearning for the object of his affection; the expression of mourning for lost joys, for happy days gone forever; then abruptly changing to a major key, the tones get faster and more agitated; and from the whirlpool of harmony the melody gradually detaches itself, alternately drowned in the foam of overbreaking waves, to reappear floating on the surface with undulating motion—collecting as it were fresh power for a renewed burst of fury. But quickly as the storm came it is gone again, and the music relapses into the melancholy yearnings of heretofore.'"—*The Land beyond the Forest*, vol. ii, pp. 122–4. London, 1888.

After the evidence thus furnished, argument is almost superfluous. The origin of music as the developed language of emotion seems to be no longer an inference but simply a description of the fact.

THE RELATIONS OF MEN OF SCIENCE TO THE GENERAL PUBLIC.*

By Prof. T. C. MENDENHALL.

JUST fifty years have passed since a small body of enthusiastic students of geology and natural history organized themselves into an association which was, for the first time in the history of this country, not local in its membership or in its purpose. As the "Association of American Geologists and Naturalists," it was intended to include any and all persons, from any and all parts of the country, who were actively engaged in the promotion of natural history studies, and who were willing to re-enforce and strengthen each other by this union. So gratifying was the success of this undertaking that after a few years of increasing prosperity under its first name, the Association wisely determined to widen the field of its operations by resolving itself into the American Association for the Advancement of Science, thus assuming to be in title what it had really been in fact, from the beginning of its existence. One of the articles of its first constitution, adopted at its first meeting, provided that it should be the duty of its president to present an address at a general session following that over which he presided. The performance of this duty can not, therefore, be easily avoided by one who has been honored by his fellow-members in being called upon to preside over the deliberations of this Association; nor can it be lightly disposed of when one realizes the importance of the occasion and recalls the long list of his distinguished predecessors, each of whom in his turn has brought to this hour at least a small measure of the work of a lifetime devoted to the interests of science.

The occasion is one which offers an opportunity and imposes an obligation. The opportunity is in many ways unique and the obligation is correspondingly great. In the delivery of this address the retiring president usually finds himself in the presence of a goodly number of intelligent people, representatives of the general public who, knowing something of the results of scientific investigation, have little idea of its methods, and whose interest in our proceedings, while entirely cordial and friendly, is often born of curiosity rather than a full appreciation of their value and importance. Mingled with them are the members and Fellows of the Association who have come to the annual gathering laden with the products of many fields which they have industriously cultivated during the year; each ready to submit his contri-

* Address of the retiring President of the American Association for the Advancemen of Science. Delivered at the Indianapolis meeting, August, 1890.

bution to the inspection and criticism of his comrades, and all hoping to add in some degree to the sum total of human knowledge.

The united presence of these two classes intensifies the interest which naturally attaches to an occasion like this, and not unnaturally suggests that a brief consideration of the relations that do exist and which should exist between them may afford a profitable occupation for us this evening.

In the beginning it may be truthfully affirmed that no other single agency has done as much to establish these relations on a proper basis as the American Association for the Advancement of Science. In the first article of its constitution the objects of the Association are defined as follows: "By periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of the United States, to give a stronger and more general impulse and a more systematic direction to scientific research in our country, and to procure for the labors of scientific men increased facilities and a wider usefulness." So perfectly do these words embody the spirit of the Association that when, more than thirty years later, the constitution was thoroughly revised, none better could be found to give it expression. That it has been successful in promoting intercourse between those who are cultivating science in different parts of the United States may be proved by the testimony of thousands who have come to know each other through attendance at its meetings. In a country whose geographical limits are so extensive as ours and whose scientific men are so widely scattered, it is difficult to overestimate its value in this particular.

In giving a stronger and more general impulse and a more systematic direction to scientific research in our country it has been singularly fortunate. Its meetings have been the means of disseminating proper methods of investigation and study throughout the land; hundreds of young students, enthusiastic but often not well trained, have found themselves welcome (sometimes to their own astonishment), and by its influence and encouragement have been molded and guided in the utilization of their endowments, occasionally exceptional, to the end that they have finally won a fame and renown which must always be treasured by the Association as among its richest possessions. Wherever its migratory meetings have been held the pulse of intelligence has been quickened, local institutions have been encouraged and strengthened, or created where they did not before exist, and men of science have been brought into closer relations with an intelligent public.

But it is in relation to the last of the three great objects, to accomplish which the Association was organized, namely, "to procure for the labors of scientific men increased facilities and a wider usefulness," that it has been, on the whole, less successful. It is true that when we look at the history of science in America during the past fifty years; when we see at every point evidences of public appreciation, or at least appropriation of scientific discovery; and, most of all, when we observe the enlargement of older institutions of learning to make room for instruction in science, and the generous donations to found new technical and scientific schools, together with an occasional endowment of research, pure and simple—in view of all these, I say, we are almost constrained to believe that scientific men have only to ask, that their facilities may be increased, and that their labors could hardly have a wider usefulness.

Unfortunately, this pleasing picture is not a true reflection of the actual condition of things. The attentive observer can not fail to discover that the relation between men of science and the general public is not what it should be in the best interests of either or both. In assemblages of the former it is common to hear complaints of a lack of appreciation and proper support on the part of the latter, from whom, in turn, occasionally comes an expression of indifference, now and then tinctured with contempt for men who devote their lives and energies to study and research, the results of which can not always be readily converted into real estate or other forms of taxable property. It can not be denied that the man of science is at some disadvantage as compared with his neighbor, the successful lawyer or physician, when it comes to that distribution of confidence with responsibility which usually exists in any well-ordered community, although the latter may possess but a fraction of the intellectual power and sound judgment which he can command. To his credit it may be said that he is usually considered to be a harmless creature, and to render him assistance and encouragement is generally regarded as a virtue. The fact of his knowing much about things which do not greatly concern the general public is accepted as proof that he knows little of matters that seriously affect the public welfare.

It is true that when the public is driven to extremities it sometimes voluntarily calls upon the man of science, and in this emergency it is often unpleasantly confronted with the fact that it does not know where to find him. The scientific *dilettante,* or worse, the charlatan, is often much nearer the public than the genuine man of science, and the inability to discriminate sometimes results in disaster in which both science and the public suffer.

In venturing to suggest some possible remedies for this condition of things it will be logical, if not important, to roughly define the two classes under consideration, the scientific and the non-scientific. One is the great majority, the general public, including in the United States over sixty millions of people in all conditions, cultured and uncultured, educated and uneducated, but in average intelligence, we are proud to say, superior to the people of any other nation in the world. Out of these it is not easy to sift by definition the small minority properly known as men of science. Only a rough approximation may be reached by an examination of the membership of scientific societies.

The American Association for the Advancement of Science includes in its membership about two thousand persons. It is well known, however, that many of these are not actually engaged in scientific pursuits, either professionally or otherwise; indeed, it is one of the important functions of the society to gather into its fold as many of this class as possible. The fellowship of the Association is limited however, by its constitution, to such members as are professionally engaged in science, or have by their labors aided in advancing science. They number about seven hundred, but in this case it is equally well known that the list falls far short of including all Americans who by their labors in science are justly entitled to a place in any roll of scientific men. On the whole, it would not, perhaps, be a gross exaggeration to say that not more than one in fifty thousand of our population could be properly placed upon the list, even with a liberal interpretation of terms.

In this estimate it is not intended, of course, to include that large class of active workers whose energies are devoted to the advancement of applied science. Although their methods are often the result of scientific training, and while the solution of their problems requires much knowledge of science, the real advancement of science at their hands is rather incidental than otherwise. In certain particulars they may be likened to the class known as "middle-men" in commercial transactions, the connecting link between producer and consumer. It is in no way to their discredit that they usually excel both of these in vigilance and circumspection and in their quick perception of utility. By them the discoveries of science are prepared for and placed upon the market, and it is difficult to overestimate their usefulness in this capacity. It is true that the lion's share of the profit in the transaction is generally theirs, and that they are often negligent in the matter of giving the philosopher the credit to which he is entitled, but for the latter, at least, it is believed that the philosopher is himself often responsible.

If this statement of the relative numbers of the scientific and the non-scientific is reasonably correct, the scientific man may at least congratulate himself on wielding an influence in affairs vastly greater than the census, alone, would justify; and this fact encourages the belief that, if there is anything "out of joint" in his relations with the general public, the remedy is in his own hands.

Let our first inquiry be, then, in what particular does he fail in the full discharge of his duties as a man of science and especially as an exponent of science among his fellows?

Without attempting to arrange the answers which suggest themselves in logical order, or, indeed, to select those of the first importance, I submit, to begin with, his inability or unwillingness, common but by no means universal, to present the results of his labors in a form intelligible to intelligent people. When inability, it is a misfortune, often the outgrowth, however, of negligence or indifference; when unwillingness, it becomes at least an offense, and one not indicative of the true scientific spirit. Unfortunately, we are not yet entirely out of the shadow of the middle ages, when learning was a mystery to all except a select few, or of the centuries a little later, when a scientific treatise must be entombed in a dead language or a scientific discovery embalmed in a cipher.

Many scientific men of excellent reputation are to-day guilty of the crime of unnecessary and often premeditated and deliberately planned mystification; in fact, almost by common consent this fault is overlooked in men of distinguished ability, if, indeed, it does not add a luster to the brilliancy of their attainments. It is usually regarded as a high compliment to say of A that, when he read his paper in the Mathematical Section, no one present was able to understand what it was about; or of B and his book that there are only three men in the world who can read it. We greatly, though silently, admire A and B, while C, the unknown, who has not yet won a reputation, and who ventures to discuss something which we do understand (after his clear and logical presentation of the subject), must go content with the patronizing admonition that there is really nothing new about this, and that if he will consult the pages of a certain journal of a few years ago, he will find the same idea, not developed, it is true, but hinted at and put aside for future consideration, or that he will find that Newton or Darwin declared what is essentially the same principle many years before. No one can deny that there are great reason and good judgment displayed in all this, but the ordinary layman is likely to inquire whether it is distributed and apportioned with nice discrimination; and it is the standpoint of the layman which we are occupying at the present moment.

All will admit that there are many men whose power in original thinking and profound research is far greater than their facility of expression, just as, on the other hand, there are many more men whose linguistic fluency is unembarrassed by intellectual activity, and representatives of both classes may be found among those usually counted as men of science. It is with the first only that we are concerned at the present moment, and it is sufficient to remark that their fault is relatively unimportant and easily overlooked. Among them is often found that highly prized but imperfectly defined individual known as the "genius," for whose existence we are always thankful, even though his interpretation is difficult and laborious.

Concerning those who, although able, are unwilling to take the trouble to write for their readers or speak for their hearers, a somewhat more extended comment may be desirable. It is always difficult to make a just analysis of motives, but there can be little doubt that some of these are influenced by a desire to imitate the rare genius whose intellectual advances are so rapid and so powerful as to forbid all efforts to secure a clear and simple presentation of results. The king is lame and the courtier must limp. With others there is a strange and unwholesome prejudice against making science intelligible, for fear that science may become popular. It is forgotten that clear and accurate thinking is generally accompanied by the power of clear, concise, and accurate expression, and that as a matter of fact the two are *almost* inseparable. The apparent success before the people of the *dilettante* and the charlatan has resulted, in the case of many good and able men, in a positive aversion to popular approval. It should never be forgotten that the judgment and taste of the public in matters relating to science are just as susceptible of cultivation as in music and the fine arts, and that scientific men owe it to themselves to see that opportunity for this culture is not withheld. A just appreciation by the people of real merit in art has resulted in the production of great painters, sculptors, musicians, and composers, and there is every reason to believe that the best interests of science would be fostered by similar treatment. Even the great masters in science, then, can well afford to do what is in their power to popularize their work and that of their colleagues, so that through closer relations with a more appreciative public their opportunities may be enlarged and their numbers increased.

Another error into which the man of science is liable to fall is that of assuming superior wisdom as regards subjects outside of his own specialty. It may seem a little hard to accuse him of this, but nevertheless it is a mistake into which he is easily and often unconsciously led. That this is the day of specialization and specialists every student of science learns at the very threshold of his career; but that one man can be expected to be good authority on not more than one or two subjects is not so generally understood by the public. It thus frequently happens that the man of science is consulted on all matters of a scientific nature, and he is induced to give opinions on subjects only remotely, if at all, related to that branch of science in which he is justly recognized as an authority. Although going well for a time, these opinions often prove to be erroneous in the end, resulting in a diminution of that confidence which the public is, on the whole, inclined to place in the dictum of science.

Examples of this condition of things are by no means wanting, and they are not confined, as might at first be assumed, to the lower ranks of science. A distinguished botanist is consulted and advises concerning the location of the natural-gas field; a mathematician advises a company in which he is a stockholder in regard to the best locality for boring for oil; and a celebrated biologist examines and makes public report upon a much-talked-of invention in which the principles of physics and engineering are alone involved.

In these and many other instances which might be related, the motives of those concerned, at least on one side of the transaction, can not be questioned, but certainly their judgment is open to criticism; and the outcome of it all is that the confidence of the people in scientific methods and results is weakened. Fifty years ago or a hundred years ago, there was good reason for much of this sort of thing. Specialization was neither as possible nor as necessary as now; the sparseness of the population of the country, the absence of centers of learning and scientific research, the obstacles in the way of easy and rapid communication between different parts of the country—all these and other circumstances contributed to the possibility of a Franklin, who wrote and wrote well upon nearly all subjects of human thought; whose advice was sought and given in matters relating to all departments of science, literature, and art. Combining in an extraordinary degree the power of profound research with a singularly simple and clear style in composition, together with a modesty which is nearly always characteristic of the genuine student of nature, he wisely ventured further than most men would dare to-day in the range of topics concerning which he spoke with authority.

But at the present time and under existing conditions there is little excuse for unsupported assumption of knowledge by men of science; and, fortunately, the danger of humiliating exposure is correspondingly great. The specialist is everywhere within easy reach, and the expression of opinions concerning things of which one knows but little is equally prejudicial to the interests of science and society.

The scientific man should also be at least reasonably free from egotism in matters relating to his own specialty, and particularly in reference to his own authority and attainments therein. In controversy he has the advantage over most disputants in that he can usually call to his support an unerring and incontrovertible witness. A well-conducted experiment or an exhaustive investigation carried out with scrupulous honesty, deservedly carries great weight; but it must not be forgotten that it does not, in a very great degree, depend upon the personality of him who directs the experiment or plans the investigation. One must not confound himself and his work to the extent of assuming that upon him ought to be bestowed the praise and admiration to which his work is perhaps justly entitled. This blunder is analogous to that of the mechanic in whom the first symptom of insanity appeared as a conviction that he was as strong as the engine which he had built, evidence of which he unpleasantly thrust upon any who might deny the truth of his assertion. "By your works shall ye be judged" may be especially affirmed of men of science, not only as regards the judgment of the public, but particularly that of their colleagues and fellow-workers. Least of all should title, degree, membership in learned societies, or the possession of medals or other awards of distinction and honor, be paraded unduly, or offered by himself in evidence of his own fitness. In general these are honorable rewards which are justly prized by scientific men, but some of them have been so indiscriminately bestowed, and in some instances falsely assumed, that the general public, not yet properly educated in this direction, does not attach great value to them as an index of real scientific merit. Where real merit actually exists, nothing is usually gained and much is likely to be lost by boastful announcements of high standing or of accumulated honor. A distinguished man of science, at the end of a controversy into which he had been called as such, complained that he had not been recognized as a Fellow of the Royal Society. "You gave us no reason to suspect your membership," quietly but severely replied a man of the world.

As another element of weakness in the scientific man I venture to suggest that he is often less of a utilitarian than he should be. This is a sin, if it be such, which seems especially attached to those who, unconsciously or otherwise, are imitators of men of science of the highest type. The latter are so entirely absorbed in profound investigation, and their horizon is necessarily so limited by the very nature of the operations in which they are engaged, that they are altogether unlikely to consider questions of utility; nor, indeed, is it desirable that they should. The evolution of processes and methods by means of which the complex existence of the present day is maintained, is largely the result of specialization or the division of labor. In such a scheme there is room for those who never demand more of a fact than that it be a fact; of truth, that it be truth. But even among scientific men the number of such is small, and as a class they can never be very closely in touch with the prople.

Strong to imitate, even in those characteristics which are akin to weakness, many persons of lesser note affect a contempt for the useful and the practical which does not tend to exalt the scientific man in the opinion of the public. Even the great leaders in science have been misrepresented in this matter. Because they wisely determined in many instances to leave to others the task of developing the practical applications of their discoveries, it has often been represented that they held such applications as unworthy a true man of science. As illustrating the injustice of such an opinion, one may cite the case of the most brilliant philosopher of his time, Michael Faraday, who in the matter of his connection with the Trinity House alone gave many of the best years of his life to the service of his fellow-men. The intensely "practical" nature of this service is shown by the fact that it included the ventilation of lighthouses, the arrangement of their lightning conductors, reports upon various propositions regarding lights, the examination of their optical apparatus, and testing samples of cotton, oils, and paints. A precisely similar illustration is to be found in the life of our own great physicist, Joseph Henry, who sacrificed a career as a scientific man, already of exceptional brilliancy, yet promising a future of still greater splendor, for a life of unselfish usefulness to science and to his countrymen, as Secretary of the Smithsonian Institution, as a member of the Lighthouse Board, and in other capacities for which he was especially fitted by nature as well as by his scientific training.

There is an unfortunate and perhaps a growing tendency among scientific men to despise the useful and the practical in science, and it finds expression in the by no means uncommon feeling of offended dignity when an innocent layman asks what is the use of some new discovery.

Referring to the theoretically extremely interesting spar prism of Bertrand, which under certain conditions may be used to detect traces of polarization of light, a recent writer remarks, "But for this application the prism would possess, in the eyes of the true votary of science, the inestimable value of being of no practical utility whatever."

Much is said, everywhere and at all times, about the pursuit of science for the sake of science; and on every hand it is sought to convey the impression that one who has any other object in view in interrogating Nature than the mere pleasure of listening to her replies, is unworthy of a high place among men of science. So old, so universally accepted, so orthodox, is this proposition, that it is with much hesitation that its truth is questioned in this presence. In so far as it means that one can not do anything well unless it is done *con amore*, that pecuniary reward alone will never develop genius, that no great philosopher or poet or artist will ever be other than unselfishly devoted to and in love with his work, just so far it is true, although it does not, as is often as, sumed, furnish a motive of the highest order. It is a trite saying but perhaps it can not be too often repeated, that he who lives and labors in the interest of his fellows, that their lives may be brightened, that their burdens may be lessened, is above all others worthy of the highest praise. By this standard the value of a discovery must at last be fixed, bearing in mind, of course, that the physical comfort of man is not alone to be considered. Judged by this standard, the work of Newton, of Watt, of Franklin, Rumford, Faraday, Henry, and a host of others is truly great. There should be, and there usually is, no controversy as to relative merit between the discoverer of a gem and the artist who polishes and sets it. In science, the genius of the former is unquestionably rarer and of a higher order, but his work will always be incomplete and in a great degree useless until supplemented by that of the latter.

Another demand which the public may justly make upon the man of science is that his interest in public affairs should not be less than that of other men. Through his failure in this particular, science has long suffered and is suffering in an increasing degree. This criticism is especially applicable in this country, where in theory every man is supposed to bear his share of the public burden and to take his part in the performance of public duties. Unfortunately, the attitude of the scientific man is too often one of criticism and complaint concerning matters in the disposition of which he persistently declines to interfere. It can not be denied, I think, that men well trained in the logic and methods of scientific research ought to be exceptionally well equipped for the performance of certain public duties constantly arising out of local, State, or national legislation; yet the impression is well-nigh universal, that the scientific man has no genius for "affairs." Indeed, it has been more than once affirmed that he is utterly devoid of administrative or executive ability, and even that he can not be trusted with the direction of operations which are almost wholly scientific in their nature. That there are many examples which seem to justify this belief is too true, but that there are other instances in which administrative and scientific ability have been combined is also true. Little search is required to reveal cases in which men of science have so ignored all ordinary rules and maxims of business procedure as to merit severe criticism, in which, unfortunately, the public does not discriminate between the individual and the class which he represents. It seems astonishing that one who is capable of successfully planning and executing an elaborate research, in which all contingencies are provided for, the unexpected anticipated, and all weak points guarded and protected, may utterly break down in the management of some much less complicated business affair, such as the erection of a laboratory or the planning of an expedition, and I am unwilling to believe that such failures are due to anything other than culpable negligence on the part of the individual.

It is generally recognized that, aside from all questions of a partisan political nature, this country is to-day confronted by several problems of the utmost importance to its welfare, to the proper solution of which the highest intellectual powers of the nation should be given. The computation of the trajectory of a planet is a far easier task than forecasting the true policy of a great republic, but those qualities of the human intellect which have made the first possible should not be allowed to remain idle while an intelligent public is striving to attain the last. That men of science have not, thus far, made their full contribution to the solution of some of these great problems is due to the fact that many have exhibited an inexcusable apathy toward everything relating to the public welfare, while others have not approached the subject with that breadth of preparation in the close study of human affairs which is necessary to establish the authenticity of their equations of condition. As already intimated, we do not seem to be getting on in this direction. Our own early history and the history of other nations is full of examples of eminent scientific men who were no less distinguished as publicists and statesmen. The name of Franklin is imperishable alike in the history of science and of politics. On many questions relating to exact science the Adamses spoke with confidence; Thomas Jefferson was a philosopher, and, on assuming the duties of the highest office in the gift of the people, counted his opportunities for association with men of science as one of its chiefest rewards. Other illustrations might be selected from the pages of the history of our own country; while in Europe, where science has been longer cultivated and under more favorable conditions, they are much more common. This is notably so in France, whose roll of scientific men who have distinguished themselves and their country during the past century includes many names prominent alike for the importance of their performance in her various crises of peace and war. The present President of the French Republic, himself an engineer, bears a name made famous in the history of science by the rich contributions of his ancestors, one of whom voted for the execution of Louis XVI, and was a member of the Committee of Public Safety. It would be difficult to overestimate the value to science, as well as to the public, of the presence in the halls of legislation of even a very small number of men who might stand as exponents of the methods of science and as competent authorities on the results of their application. Our national Congress, especially, is almost constantly dealing with questions of great moment to the people, which can only be thoroughly understood and wisely dealt with by scientific men, and the presence of one or two such in each branch of that body would be of decided advantage to the whole country. In the nature of things, opportunities for such representation will be rare, but when they occur they must not be suffered to escape.

Finally, if the conclusions reached in the foregoing should be thought wise, and should any young man at the threshold of his scientific career determine to be guided by them in establishing his relations with the general public, he will find splendid examples among the distinguished leaders of all departments of science. Should he desire to present the results of his labors in such a way that they may be understood by intelligent people, he may imitate Franklin, whose literary style, as to simplicity and clearness, commanded the highest praise from literary men; or Faraday, who was able to give expression to the most involved conceptions in simple English; or Tyndall, the appearance of whose Heat considered as a Mode of Motion was an epoch in the history of physical science in its relation to an intelligent constituency, without which it can not thrive. He will learn that there is no discredit in "popularizing" science; that popularizing what is not science is the thing that is to be shunned and prevented. The arrogance of genius is not less disagreeable than that of riches, although it is less common.

Should he wish to cultivate modesty in estimating his own attainments, he need only follow Newton, Darwin, and, in fact, the whole list of distinguished men of science down to the present time, with a few rare and unexplainable exceptions, the existence of which serves, like a whistling buoy, to point out what should be avoided.

Should he aspire to be of some use to the world and to leave it better because of his life, he will be encouraged by the fact, already considered, that in the long run those discoveries are most highly esteemed, and justly so, which are the most potent in their influence upon civilization and society by ameliorating the condition of the people, or by enlarging their opportunities, and that all really great men of science have not lost sight of this fact; that "science for the sake of science" does not represent the highest ideal, nor can the "almighty dollar" ever be bartered for the "divine afflatus."

All of these questions will serve to enlarge his interest in public affairs, because he will come to recognize that he is himself but a part of the public. He will remember the delight of Faraday, when near the end of his life he saw a huge dynamo illuminating the tower of a lighthouse. That which he had given to the world as an infant, in his splendid discovery of induction, had, through the fostering care of others, grown to a brilliant manhood, and he experienced exquisite pleasure in the reflection that it might be the means of saving the lives of his fellow-men. The ideal of duty which ought to be present in the mind of every man of science may well be higher than that growing out of mere selfish pleasure in the acquisition and possession of knowledge.

Perhaps it is hardly becoming in me, at this time and in some sense representing this large body of scientific men, to make even a simple remark in criticism of the general public, the party of the second part in the question which we have considered to-night. I venture to suggest, however, that whenever the public is disposed to consider its obligations to Science and her votaries, there are some things which must not be forgotten—things so important and so numerous, indeed, that many volumes would be inadequate to their enumeration. Prove this by comparing the world *with* science with the world *without* science. Take as an illustration that which less than two hundred years ago was but a spark, a faint spark, exhibited on rare occasions by the scientific man of that time. With this spark, thanks to science, the whole world is now aflame. Time and space are practically annihilated; night is turned into day; social life is almost revolutionized, and scores of things which only a few years ago would have been pronounced impossible, are being accomplished daily. Many millions of dollars of capital and many thousands of men are engaged in the development of this agent, so purely a creation of science that the Supreme Court of the land has already declared that it has no material existence. Surely science, which has brought us all these blessings, together with thousands besides, is worthy of every care and consideration at the hands of a generous and appreciative public.

THE ROOT-TIP.

By FREDERICK LEROY SARGENT.

IT is only within recent years that botanists have realized what a wonderful organ the root has at its tip. Text-books which were in use twenty-five years ago give but little more upon the subject than the statement that at the extremity of each rootlet is a minute, sponge-like organ, called the *spongiole*, by means of which the plant absorbs moisture from the ground. As long ago, however, as 1837, Ohlert* showed that if this so-called spongiole be cut off from a young root, and the wound covered with waterproof varnish, absorption takes place quite as well as before the operation; and he expressed the opinion that the true organs of absorption are numerous delicate hairs which form a velvety

* Linnæa, 1837.

zone a short distance behind the apex of a rootlet. Later investigators have confirmed Ohlert's conclusions, and have found that the terminal organ, instead of being absorbent like a sponge, is in reality a protective cap, and as impervious to water as cork. (See Fig. 1.)

Just behind this cap, and inclosed by it as a thimble covers the finger-tip, lies that part of the root which is youngest and tenderest, where growth is most vigorous, and from which all the

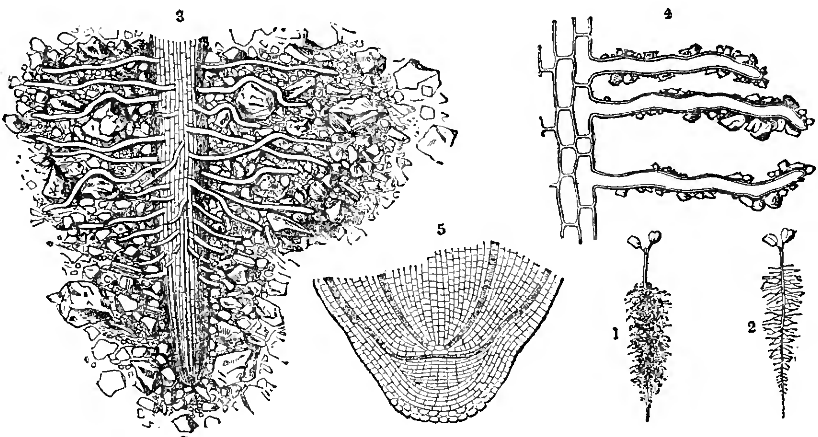


Fig. 1.—Parts of a Young Root (*Pentstemon*). (1) Seedling, with earth-particles attached to the root-hairs. (2) The same, showing the root-hairs freed from earth-particles. (3) Root-tip penetrating the soil (× 10). (4) Root-hairs with earth-particles adhering (× 50). (5) Vertical section of root-tip, showing protective cap and growing point (× 30). (Kerner.)

other tissues of the root are derived. This vegetative point we may consider as the tip proper. (See Fig. 1 (5).) As fast as the surface wears off by contact with the earth, new tissue is added beneath, much the same as one's finger-nail is constantly renewed, and thus the thickness of the cap remains about the same, although continually worn away.

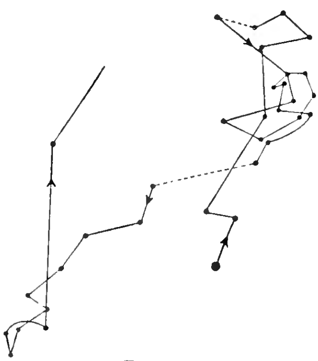
The new tissue which is added to the body of the root soon loses the power of increasing in length, and consequently the elongation of a root is in marked contrast to the elongation of a stem. The latter, to be sure, has, like the root, a small mass of formative tissue at the apex, but the tissue which is formed continues to enlarge for a comparatively long time, and the result is that a young stem grows in length at a nearly uniform rate throughout, while in a rootlet elongation takes place only near the tip. The simple experiment of making a series of equidistant ink-dots along the stem and root of a bean seedling will, as growth proceeds, give a good idea of the difference in manner of growth. It is obvious that were a root to elongate like a stem, the results could hardly fail to be disastrous: for, in the first place, the resistance of the earth would soon cause a strong curvature; and, in the second place, the tender apex would be injured by being thus forced against the earth. As it is, the tip penetrates the earth, not like a nail driven by a force behind, but like a slender, tapering cone whose point insinuates itself between the earth-particles and then by growth in thickness wedges them apart. Experiment has shown that a root in its longitudinal growth exerts but very little force; in the bean, for example, there is scarcely force enough to raise a quarter of a pound. The force of transverse growth, on the other hand, is considerable—equal in the bean to the raising of over eight pounds.*

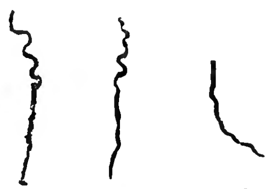
It was first demonstrated by Darwin that the elongation of the root takes place in such a way that the apex, instead of going straight forward, bends to all sides in succession and thus describes a somewhat corkscrew-like spiral. This movement he called circumnutation, and found that essentially similar movements (some of which had been before observed) were exhibited by all growing stems and leaves, and not infrequently after growth had ceased. In the case of the root, the movement may be rendered apparent in either of two ways. One method is to take a seedling growing in moist air, and magnify the movement of the root-tip by attaching to the bending portion a very slender filament of glass several inches in length, and then, on a sheet of glass kept perpendicular to the axis of the root, record by ink-dots the different points to which the filament is from time to time directed. Upon connecting the dots made at short intervals through a period of several hours, a result is obtained somewhat like that shown in Fig. 2. The other method is to allow the vertical root of a seedling to grow downward against the smoked surface of a piece of glass which is held oblique to the axis. If the conditions are favorable, the tip will be found to rub the surface and leave a serpentine tracing similar to those given in Fig. 3. That the course of the tip had been spiral and not zigzag was shown in Darwin's experiments by alternating regions of greater and less rubbing, and in some cases by transverse ridges of soot. Since these experiments can not be performed with the root imbedded in compact earth, we can not say how far circumnutation may take place in ordinary soil, but undoubtedly the tendency to circumnutate is ever present, and whenever there is favorable opportunity for its exercise the spiral movement must materially assist the tip in making its way along the line of least

* For the details of this experiment, as of others to be mentioned later, the reader is referred to Darwin's Power of Movement in Plants, which contains the most valuable contributions to our knowledge of the root-tip that have ever been made.

resistance. The chief importance of this power of movement, however, comes from the way it may be modified, and its force augmented in certain directions by different influences.

Prominent among these influences is that of gravity. A most noticeable fact in the sprouting of seeds is that the root points toward the center of the earth, and the young shoot in the opposite direction, and it has long been known that this tendency to assume the vertical can not be explained as a response to differences in illumination, warmth, or moisture, since the organs behave just the same when seedlings are grown under conditions where these differences are entirely eliminated. Moreover, if a root which has been growing downward be placed in a horizontal position, the region of growth, for a few millimetres behind the tip, will in the course of some hours bend so as to bring the tip into its original vertical position; and as this bending will take place against an appreciable resistance, it follows that the assumption of the new position is not a mere drooping, but is a movement actively performed as if in response to a stimulus.





A. B. C.

Fig. 2. Fig. 3.

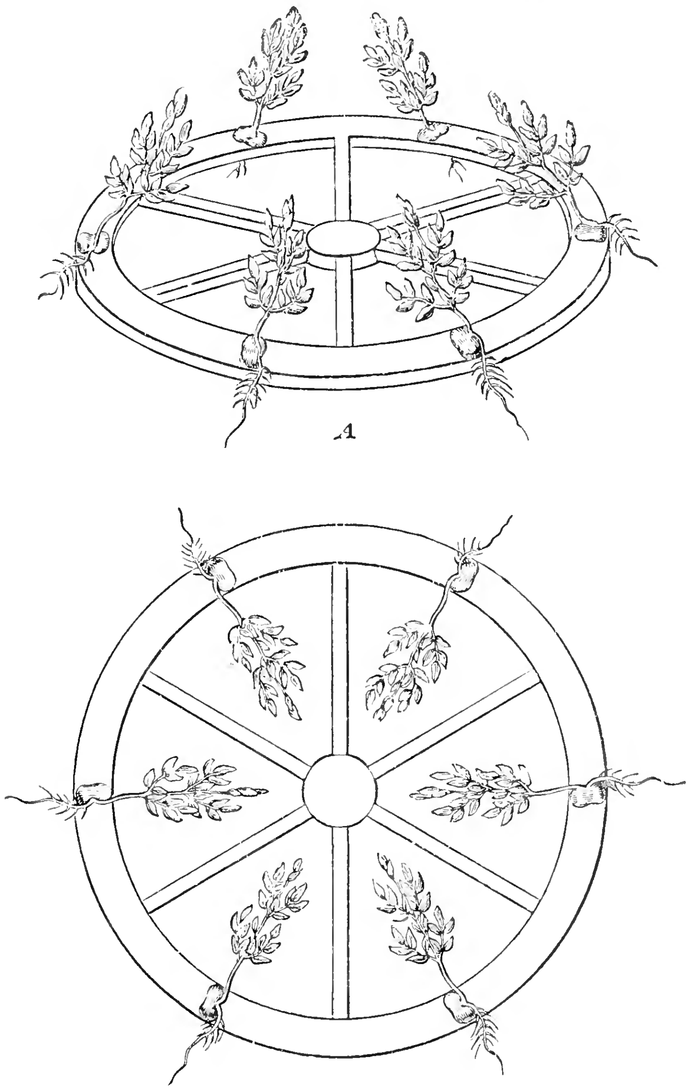
Fig. 2.—Circumnutation of Radicle (*Brassica*)—traced on horizontal glass from 9 a. m. January 31st, to 9 p. m. February 2d. Movement much magnified. (From Darwin's Power of Movement in Plants.)

Fig. 3.—Tracks left on Inclined Smoked Glass Plates by Tips of Radicles (*Phaseolus*) in growing downward. A and C, plates inclined at 60°; B, inclined at 68° with the horizon. (From Darwin's Power of Movement in Plants.)

That gravity is the stimulus which evokes this response, was first proved by Knight in 1806.* He reasoned that "as gravitation could produce these effects only while the seed remained at rest and in the same position relative to the attraction of the earth, . . . its operation would become suspended by constant and rapid change of position of the germinating seed, and it might be counteracted by the agency of centrifugal force." He accordingly attached a number of germinating beans in various positions to

* On the Direction of the Radicle and Germen during the Vegetation of Seeds. Thomas Andrew Knight. Philosophical Transactions, vol. xcvi.

the rim of a wheel, and this, placed in a box sufficiently warm and damp, was made to turn in a vertical plane at the rate of one hundred and fifty revolutions a minute. After a few days, the parts of the seedlings were found to be in the position shown in



A

B

FIG. 4.—DIAGRAMS ILLUSTRATING KNIGHT'S EXPERIMENTS. *A*, wheel rotating horizontally; the plants grow under the combined influence of gravity and centrifugal force. *B*, wheel rotating vertically; the direction of growth is determined by centrifugal force alone. (Vines.)

Fig. 4, B. Fig. 4, A, shows the position assumed by seedlings placed under conditions entirely similar, except that the wheel was made to turn horizontally. Since both gravity and centrifugal force were here acting at right angles to each other upon the seedlings, the oblique direction of their axes shows that they were affected by the resultant of the two forces concerned, in just the manner called for by Knight's supposition.

Although gravity is thus seen to be the influence which induces a downward tendency in roots, it of course does not follow that all the younger parts of a root-system are equally affected. While it is the rule for primary roots, or those first developed, to grow downward, the secondary branches usually tend to assume a direction almost at right angles to the vertical, and so grow outward and a little downward, as if they were but slightly susceptible to the action of gravity; while tertiary branches, and the farther branches to which these give rise, grow in all directions quite independent of gravity. It is plain that as a result of these peculiarities the active parts of the root are distributed in such a manner as to search the surrounding earth more thoroughly than would otherwise be possible.

In case a stone or other obstruction is encountered by any of the branches, the tip is turned aside and follows the contour closely until the edge is reached, when it soon assumes its proper direction. Not infrequently it must happen that some root-eating animal will destroy the end of a young primary root, and so endanger the proper development of the whole system, but experiment has shown that in the event of such injury one of the younger secondary branches changes its direction of growth so as to point directly downward and thus assume the function of the primary root to promote the search for food in the deeper regions.

At first sight it would seem that surely gravity must affect all parts of the growing region of a rootlet in the same manner, since all parts are equally exposed to its influence. In 1871, however, Ciesielski * announced that rootlets from which the tip had been carefully removed with a razor lost all sensitiveness to gravity until a new tip had grown, when the behavior became normal. Other investigators failed to obtain the same results; but some years later Darwin repeated Ciesielski's experiments successfully, and confirmed his conclusion that it is the tip alone which is sensitive to gravity, and from this part the stimulus is transmitted to the adjoining region of growth, which bends downward in consequence.

Another influence to which roots are very sensitive is that of moisture. This is strikingly exhibited in an experiment devised by Sachs. Seeds are made to germinate in a layer of moist sawdust, contained in a sieve-like framework, and this suspended obliquely as shown in Fig. 5. The young roots grow directly down-

* Abwärtskrümmung der Wurzel. Inaugural Dissertation. Breslau, 1871.

ward through the loose mass and out through the meshes of the sieve, when, instead of continuing vertically, they bend toward the moisture which comes from the sawdust and keep close to the inclined surface in spite of gravity.

With a view to seeing whether this sensitiveness to moisture was localized like the sensitiveness to gravity, Darwin covered the tips of a number of seedlings with grease, and then subjected them to an excess of moisture on one side. No bending occurred so long as the tips remained covered. This led him to believe that sensitiveness to moisture is confined to the same part which is sensitive to gravity, and later investigators, using improved methods, have confirmed Darwin's conclusion. The lateral branches, being less controlled by gravity than the main axis, are, as might be expected, more responsive to differences in moisture. So delicate is this sensitiveness that the roots oftentimes seem to work almost intelligently in their search for water. Thus elm roots have been found filling up a drain fifty yards from the trunk, and numerous instances of roots growing into wells and choking water-pipes have been reported.

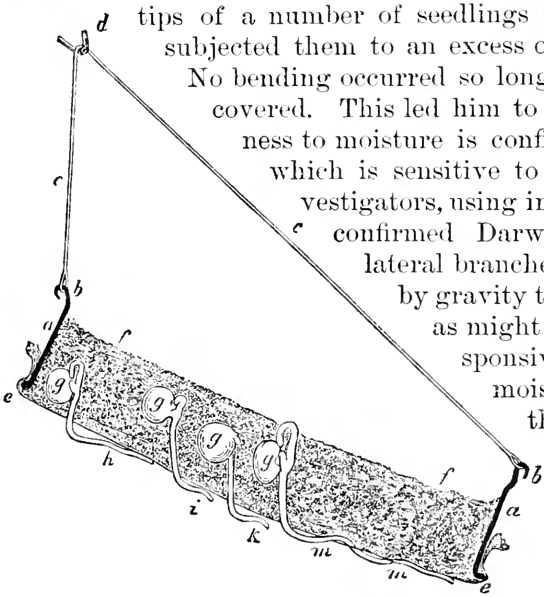


Fig. 5.—Apparatus to illustrate the Mode in which the Influence of Gravity is overcome by the Effect of Greater Moisture on one Side of the Root. (Sachs.)

A very common effect of this special sensitiveness is to regulate the distribution of the rootlets in accordance with the water-shed from the leaves. The greater part of our trees shed the rain outward like a dome or spire, so that the region of earth best watered falls directly under what may be called the eaves: it is just here that the tips of the rootlets occur in most profusion. In the case of shrubs and herbs, which are more apt to grow close together, the water-shed is, of course, mostly indefinite, and as a consequence no regularity is apparent in the distribution of the rootlets; but even among herbs quite definite water-shed is not uncommon, and as with trees the effect upon the rootlets is well marked largely in proportion to the isolation of the plants. Certain kinds shed the water outwardly like the trees (Fig. 6, 1), while others have the leaves so disposed as to act like a funnel and carry the water toward the axial root around which the short rootlets are developed (Fig. 6, 2).

It has already been mentioned that the root-tip, when coming against an obstruction, turns aside and thus avoids being pushed against it. This has been taken to indicate that the tip is sensitive to contact as well as to moisture and gravity. To test this supposition, Darwin tried the experiment of affecting one side of the root-tip with a slight but constant mechanical irritant. In

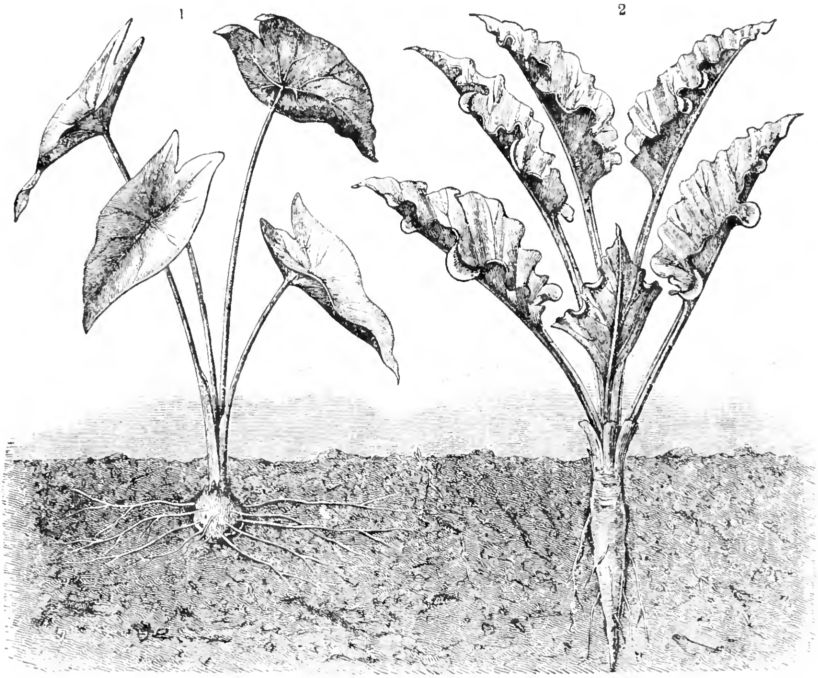
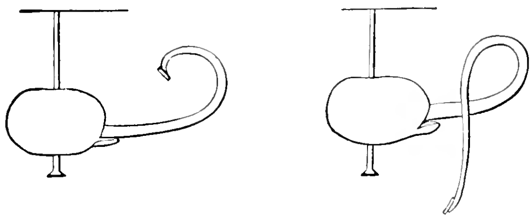


FIG. 6.—(1) CENTRIFUGAL WATER-SHED IN CALADIUM, AND (2) CENTRIPETAL WATER-SHED IN RHUBARB—showing corresponding distribution of rootlets. (Kerner.)

some cases the irritation was produced by a tiny bit of card attached obliquely to the tip by shellac or gum; shellac by itself was sometimes used, and in other instances the sensitive region was touched with caustic. In nearly every case the tip became bent away from the side irritated (Fig. 7). Occasionally it happened that the region just above the tip became irritated (by displacement of the card or otherwise), and in such cases the end of the root was bent strongly *toward* the source of irritation. These results seem to warrant the conclusion that the end of the root is not only sensitive to contact, but responds in opposite ways according as the side of the tip or the region just above is affected, and we get an explanation both of the way the tip bends when meeting an obstructing surface, and of the abrupt curve it makes when the edge of the obstruction is reached. It has been urged, however, that these experiments do not really prove that the root-tip is sensitive to mere contact, since a certain amount of injury to the tissues was inflicted by the method employed; and this objection has not so far been fully met. Whatever may be the true explanation, it is a fact that roots find their way into worm-burrows, and otherwise follow in the earth lines of least resistance, in a way that is strongly suggestive of a power to discriminate between harder and softer regions of the soil.



A. B.

Fig 7.—A Seedling of Pea, with radicle extended horizontally in damp air, with a little square of card affixed to the lower side of its tip, causing it to bend upward in opposition to gravity. The deflection of the radicle after twenty-one hours is shown at A, and of the same radicle after forty-five hours at B. (From Darwin's Power of Movement in Plants.)

An electric current passed through the tip induces curvature, and in some cases roots have been found to bend away from the light. Although it can hardly be supposed that sensitiveness to these stimuli is of any special use to the plants, such behavior, taken in connection with the highly useful modes of sensitiveness above described, surely indicates an almost animal-like irritability of the organ in question.

From what has been said of the curvature of young roots, it is obvious that, whenever the tip proper is stimulated, the effort must be transmitted to the part above, since it is only this upper portion which curves. A similar transmission of stimulus takes place in the leaf of the sensitive-plant, and both suggest an analogy with the propagation of an impulse along the nerves in animals. Nevertheless, in the absence of all proof that anything resembling nerves entered into the structure of plants, the analogy referred to was deemed rather fanciful, and certain mechanical explanations of the phenomena were offered as more in keeping with what was known. A few years ago, however, Gardiner's demonstration of the continuity of protoplasm in plants * rendered the mechanical theories superfluous, by showing that the living matter of adjacent cells was connected by delicate protoplasmic threads which might fairly be considered the analogues of nerves. The essential similarity of many plant movements with those of animals is thus seen to be even closer than was at first supposed,

* Philosophical Transactions, 1883, p. 817.

and an added significance is given to the following words of Darwin, with which he closes his memorable work: "We believe that there is no structure in plants more wonderful, as far as its functions are concerned, than the tip of the radicle. If the tip be lightly pressed, or burnt or cut, it transmits an influence to the upper adjoining part, causing it to bend away from the affected side; and, what is more surprising, the tip can distinguish between a slightly harder and softer object, by which it is simultaneously pressed on opposite sides. If, however, the radicle is pressed by a similar object a little above the tip, the pressed part does not transmit any influence to the more distant parts, but bends abruptly toward the object. If the tip perceives the air to be moister on one side than on the other, it likewise transmits an influence to the upper adjoining part, which bends toward the source of moisture. When the tip is excited by light, . . . the adjoining part bends from the light; but when excited by gravitation, the same part bends toward the center of gravity. In almost every case we can clearly perceive the final purpose or advantage of the several movements. Two, or perhaps more, of the exciting causes often act simultaneously on the tip, and the one conquers the other, no doubt in accordance with its importance for the life of the plant. The course pursued by the radicle in penetrating the ground must be determined by the tip; hence it has acquired such diverse kinds of sensitiveness. It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements."

MY CLASS IN GEOMETRY.

By GEORGE ILES.

A VIVID recollection of my boyhood is the general disfavor with which my school-fellows used to open Euclid. It was in vain the teacher said that geometry underlies not only architecture and engineering, but navigation and astronomy. As we never had any illustration of this alleged underlying to make the fact stick in our minds, but were strictly kept to theorem and problem, Euclid remained for most of us the driest and dreariest lesson of the day. This was not the case with me, for geometry happened to be my favorite study, and the easy triumph of leading the class in it was mine. As years of active life succeeded my school-days I could not help observing a good many examples of the truths set forth in the lines and figures I had conned as a boy; examples which, had they been presented at school, would certainly have somewhat diminished Euclid's unpopularity. In fullness of time it fell to my lot to be concerned in the instruction of three boys—one of fourteen, the second twelve, the third a few months younger. In thinking over how I might make attractive what had once been my best-enjoyed lessons, I took up my ink-stained Euclid—Playfair's edition. A glance at its pages dispossessed me of all notion of going systematically through the propositions—they took on at that moment a particularly rigid look, as if their connection with the world of fact and life was of the remotest. Why, I thought, not take a hint from the new mode of studying physics and chemistry? If a boy gets a better idea of a wheel and axle from a real wheel and axle than from a picture, or more clearly understands the chief characteristic of oxygen when he sees wood and iron burned in it than when he only hears about its combustive energy, why not give him geometry embodied in a fact before stating it in abstract principle? Deciding to try what could be done in putting book and blackboard last instead of first, I made a beginning. Taking the boys for a walk, I drew their attention to the shape of the lot on which their house stood. Its depth was nearly thrice its width, and a low fence surrounded it. As we went along the road, a suburban one near Montreal, we noticed the shapes of other fenced lots and fields. Counting our paces and noting their number, we walked around two of the latter. This established the fact that both fields were square, and that while the area of one was an acre and a half, that of the other was ten. When we returned home the boys were asked to make drawings of the house-lot and of the two square fields, showing to a scale how they differed in size. This task accomplished, they drew a diagram of the house-lot as it would be if square instead of oblong. With a foot-rule passed around the diagram it was soon clear to them that, if the four sides of the lot were equal, some fencing could be saved. The next question was whether any other form of lot having straight sides could be inclosed with as little fence as a square. Rectangles, triangles, and polygons were drawn in considerable variety and number and their areas calculated, only to confirm a suspicion the boys had entertained from the first—that of lots of practicable form square ones need least fencing. In comparing their notes of the number of paces taken in walking around the two square fields, a fact of some interest came out. While the larger field contained nearly seven times as much land as the other, it only needed about two and a half times the length of fencing to surround it. Taking a drawing of the larger inclosure, I divided it into four equal parts by two lines drawn at right angles to each other. It only needed a moment for the boys to perceive how these lines of division, representing as they did so much new fencing, explained why the small field had proportionately to area so much longer a boundary than the large one.

A chess-board served as another illustration. Taking each of its sixty-four squares to represent a farm duly inclosed, it was easy to see how a farmer rich enough to buy the whole number, were he to combine them in one stretch of land, could dispense with an immense quantity of lumber or wire fencing. During a journey from Montreal to Quebec the boys had their attention directed to the disadvantageous way in which many of the farms had been divided into strips long and narrow. "Just like a row of chess squares run together," said one of the lads.

When a good many examples had impressed the lesson on their minds pretty thoroughly, I had them write under their drawings, taking care that the terms used were understood: "Like plane figures vary in boundary as their like linear dimensions; they vary in area as the *square* of their like linear dimensions." It proved, however, that while the boys knew this to be true of squares, they could not at first comprehend that it was equally true of other forms. They drew equilateral and other triangles and ascertained that they conformed to the rule, but I was taken aback a little when the eldest boy said, "It isn't so with circles, is it?" His doubt was duly removed, but the remark showed how easy it is to make words outrun ideas; how hard it is for a young mind to recognize new cases of a general law with which in other examples it is quite familiar.

One chilly evening the sitting-room in which my pupils and I sat was warmed by a grate-fire. Shaking out some small live coals, I bade the boys observe which of them turned black soonest. They were quick to see that the smallest did, but they were unable to tell why. They were reminded of the rule they had committed to paper, but to no purpose, until I broke a large glowing coal into a score of fragments which became black almost at once. Then one of them cried, "Why, smashing that coal gave it more surface!" This young fellow was studying the elements of astronomy at school, so I had him give us some account of how the planets differ from one another in size, how the moon compares with the earth in mass, and how vastly larger than any of its worlds is the sun. Explaining to him the theory of the solar system's fiery origin, I shall not soon forget his keen delight—in which the others presently shared—when it burst upon him that because the moon is much smaller than the earth it must be much colder; that, indeed, it is like a small cinder compared with a large one. It was easy to advance from this to understanding why Jupiter, with eleven times the diameter of the earth, still glows faintly in the sky; and then to note that the sun pours out its wealth of heat and light because the immensity of its bulk has, comparatively speaking, so little surface to radiate from.

To make the law concerned in all this definite and clear, I took eight blocks, each an inch cube, and had the boys tell me how much surface each had—six square inches. Building the eight blocks into one cube, they then counted the square inches of its surface—twenty-four; four times as many as that of each separate cube. With twenty-seven blocks built into a cube, they found that structure to have a surface of fifty-four square inches, nine times that of each component block. As the blocks underwent the building process, a portion of their surfaces came into contact, and thus hidden could not count in the outer surfaces of the large cubes. Observation and comparison brought the boys to the rule which told exactly what proportion of surface remained exposed. They wrote, "Like solids vary in surface as the *square*, and in contents as the *cube* of their like dimensions." They were glad to note that the first half of their new rule was nothing but their old one of the farms and fields over again.

As the law at which we had now arrived is one of the most important in geometry, I took pains to illustrate it in a variety of ways. Taking a long, narrow vial of clear glass, nearly filled with water and corked, I passed it around, requesting each of the boys to shake it smartly, hold it upright, and observe which of the bubbles came to the surface first. All three declared that the biggest did, but it was a little while before they could be made to discern why. They had to be reminded of the cinders and the building-blocks before they saw that a small bubble's comparatively large surface retarded its motion through the water. The next day we visited Montreal's wharves, and, pacing alongside several vessels, jotted down their length. In response to questions, the boys showed their mastery of the principle which decides that the larger a ship the less is its surface in proportion to tonnage. Going aboard an Allan liner, of five thousand tons burden, we descended to the engine-room; we next visited a steamer of somewhat less than one thousand tons, and inspected her engines—engines having proportionately to power much larger moving surfaces to be retarded by friction than those we had seen a few minutes before. On being reminded of their experiments with the vial, the boys were pleasantly surprised to find that the largest bubble and the ocean racer come first to their respective ports by virtue of their identical quality of bigness, by reason of the economies which dwell with size. As we walked homeward, the youngest of our party espied a street-vender with a supply of gaudy toy-balloons. One of them bought, I dare say the little fellow's mind was pretty confident that there was no Euclid in that plaything. It proved otherwise. That evening he calculated how much the lifting power of his balloon would gain on its surface were its dimensions increased one thousand or ten thousand fold—step by step approaching the conclusion that, if air-ships are ever to be manageable in the face of adverse winds, they must be made vastly larger than any balloons as yet put together.

Not far from home stood a large store, displaying a miscellaneous stock of groceries, fruits, dry goods, shoes, and so on. As we cast our eyes about its shelves, counters, and floor, we saw many kinds of packages—cans of fish, marmalade, and oil, glass jars of preserves and olives, boxes of rice and starch, large paper sacks of flour. Outside the door stood half a dozen empty barrels and packing-cases. It certainly seemed as if the cost of paper, glass, tin, and lumber for packages must be an important item in retailing. One after another the boys discovered that the store was giving them their old lesson in a new form. They saw that the larger a jar or box the less material it needed. On their return home they were gradually led up to finding that form as well as size is an element in economy. Just as farms square in shape need least fence, they found that a cubical package needs least material to make it, and that tins of cylindrical form require least metal when of equal breadth and height.

Our next lesson was one for lack of which not a few inventors and designers have wasted time and money. Taking the trio to Victoria Bridge, we asked its custodian the length of its central span. His reply was, three hundred and fifty-two feet. When I asked the boys how matters would be changed if the span were twice as large, they soon perceived that, while increased in strength by breadth and thickness, it would be heavier by added length as well. On our return we compared two boards differing in each of their three dimensions as one and two, serving to make manifest why it often happens that a design for a bridge or roof, admirable as a model, fails in the large dimensions of practical construction.

One day a roofer had to be called in to make needful repairs. We went with him to the roof, and found the gutter choked with mud. How had it got there? A glance at the roof, an iron one, showed it covered with dust which the next shower would add to the deposit in the gutter. Dust-particles are extremely small and fine, and did not this explain how the wind had been able to take hold of them and carry them far up into the air? Although the boys had considerably less pocket-money than they liked, they had still enough to enable them to observe that the smallest coins were most worn. When they came to think it over, they readily hit on the reason why.

Our next lessons were intended to bring out the relations which subsist between several of the principal forms of solids. Two series of models in wood were accordingly made. The first consisted of a cube having a base five inches square, and a wedge and pyramid of similar base and height. The second series comprised a cylinder, sphere, and cone, each five inches broad and high. Taking the first series, a moment's comparison of the sides of wedge and cube told that one contained half as much wood as the other; but that the pyramid contained a third as much as the cube was not evident. Weighing the pyramid and cube brought out their relation, but a more satisfactory demonstration was desirable, for what was to assure us that the two solids were of the same specific

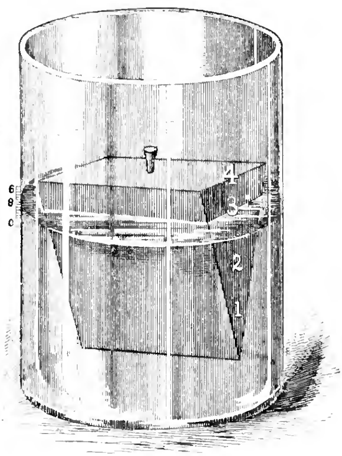


Fig. 1.

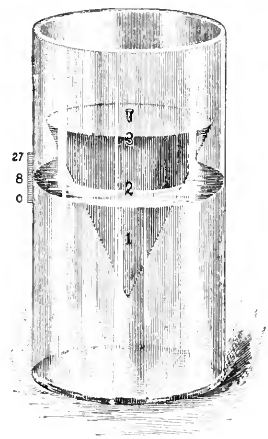


Fig. 2.

gravity? Taking a clear glass jar of an accurately cylindrical interior, measuring seven and a half inches in width by ten in height, it was half filled with water, and a foot-rule was vertically attached to its side. The models, which were neatly varnished, and therefore impervious to water, were then successively immersed and their displacement of the water noted. This proved that the pyramid had a third the contents of the cube, that the same proportion subsisted between the cone and cylinder, and that the sphere had twice the contents of the cone. Dividing the wedge by ten parallel lines an equal distance apart, I asked how the area of the smallest triangle so laid off, and that of the next smallest, compared with the area of the large triangle formed by the whole side of the wedge. "As the square of their sides," was the answer. Dipping the wedge below the surface of the water in the jar, edge downward, it was observed to displace water as the square of its depth of immersion. Reversing the process, the wedge became a simple means of extracting the square root. Dividing the vertical play of its displacement into sixteen parts drawn along the jar's side, we divided the wedge into four parts by equidistant parallel lines. Then, for example, if we sought the square root of nine, we immersed the wedge with its edge downward until it had displaced water to line nine on the jar's side. On the wedge the water stood at line three, the square root of nine. In a similar way the cone was observed to displace water as the cube of its depth of immersion, and therefore could be impressed into the service of extracting the cube root. For this purpose its total play of displacement in a jar of five and a half inches interior diameter was divided into twenty-seven parts, and the cone was marked off into three sections. To find the cube root of eight, we lowered the cone apex downward, until the water-level was brought to eight on the jar's side; at that moment the liquid encircled the cone at section two, denoting the cube root of eight. The pyramid immersed in the larger jar acted equally well as a cube-root extractor. Measuring both cone and pyramid at each of their sectional divisions, the boys were required to ascertain the rule governing their increase of sectional area, and arrived at the old familiar law of squares—a law true not only of all solids converging regularly to a point, but of all forces divergent or radiant from a center, simply because it is a law of space through which such forces exert themselves.

While I was glad to use examples and models to instruct my pupils, I wished them to grasp certain geometrical relations through exercise of imagination. They had long known that the area of a parallelogram is the product of its base and height; they were now required to conceive that any triangle has half the area of a parallelogram of equal height and base. It was easy then to show them the very old way of ascertaining the area of a circle, the method which conceives it to be made up of an indefinitely great number of triangles whose bases become the circle's circumference, and whose altitude is the circle's radius. Rolling the cylindrical model once around on a sheet of paper, its circuit was marked off; this was made the base-line of a parallelogram having a height equal to half the cylinder's breadth; half that area was clearly equal to the surface of the circle forming the cylinder's section. Another method of proving the relation between the area of a circle and its circumference was followed by the boys with fair promptness. I asked them to imagine a circular disk to be made up by the contact of a great number of concentric rings. Supposing the disk to be a foot in diameter and each ring to be the millionth of a foot wide, I inquired, "How many rings would there be?" "Half as many, half a million." To the question, "What would be the size of the average ring's circumference?" "Half that of the whole circle," was the reply. They were thus brought to it that if a circle rolled around once is found to have 3·1416 lineal units for its circumference, its area must be ·7854, or one half of one half as much, expressed in superficial units of the same order.

A terrestrial globe was the text for our next lesson. Assuming its form to be spherical, shift its axis as we might, it was clear that its center remained at rest during rotation in all planes. A hint here as to why the calculations of the astronomer are less difficult than if the planets were of other than globular form, for each orb as affected by gravitation may be practically considered as condensed at its center. Turning from astronomy to navigation, we glanced at the principle of great-circle sailing. On the equator of our terrestrial globe we found the Gillolo Islands and Cape San Francisco. A ship's shortest course plainly lay along the equatorial line which joined them. When I asked which was the shortest route from San Francisco, California, to Figami Island, Japan, the boys concurred in the wrong answer, "Along the thirty-eighth parallel." Taking a brass semicircle equal in diameter to the globe's equator, and applying it so as to touch both places, the lads saw at once that the shortest route would take a ship somewhat toward the north for the first half of her voyage; that if two ports are to be joined by an arc, the largest circle of which that arc can form a part marks out the shortest track; and that this largest or great circle is practically no other than a new equator cutting the earth in a plane inclined to the geographical equator.

By this time about a year had elapsed since our little class in geometry had been formed, and its progress was very satisfactory. The eldest boy was now studying Euclid at a high school and earning high marks for his proficiency. In the lessons I have described, and in others which followed them, all three lads showed their interest by being constantly on the lookout for new illustrations. Let an instance or two of this suffice. One day they walked to an immense sugar-refinery some distance off, paced around it, estimated its height, and brought me their calculations as to its storage capacity in comparison with that of a small warehouse near by; calculations showing how much outer wall and roof were saved in the vast proportions of the refinery. At home an extension of the house was heated in the winter by a small stove; at a neighboring station of the street railway there was a much larger stove of the same pattern. Counting efficiency to depend on surface, one of the boys asked me if it would not be better to have two small stoves instead of that large one. He was perfectly conversant with the reason why steam-fitters make their heating-coils of small pipes, and why their radiators abound in knobs and ridges.

It may be no more than the effect of bias due to an individual preference for the study, but, in the light of its influence on these three young minds, I can not help thinking that geometry affords a most happy means of developing powers of observation and reasoning. When the boys came to study plants, minerals, and insects they found their knowledge of Euclid gave them a new and vital thread whereon to string what they learned. This was even more decidedly the case when they came to study the various modes of motion and certain principles of engineering science. Mr. W. G. Spencer, the father of Herbert Spencer, in an invaluable little book * has shown how geometry can be taught so as to educe the noble faculty of invention. At the high school at Yonkers, New York, of which Mr. E. R. Shaw is principal, I have seen most original and beautiful solutions of Mr. Spencer's problems worked out by the pupils.

THE LOGIC OF FREE TRADE AND PROTECTION.

By ARTHUR KITSON.

IN an interesting chapter on the history of tariff legislation Mr. Blaine, in his Twenty Years in Congress, thus presents the issue:

"It is natural that both sides of the tariff controversy should endeavor to derive support for their principles from the experience of the country. Nor can it be denied that each side can furnish many arguments which apparently sustain its own views and theories. The difficulty in reaching a satisfactory and impartial conclusion arises from the inability or unwillingness of the disputants to agree upon a common basis of fact. If the premises could be candidly stated, there would be no trouble in finding a true conclusion. In the absence of an agreement as to the points established, it is the part of fairness to give a succinct statement of the grounds maintained by the two parties to the prolonged controversy—grounds which have not essentially changed in a century of legislative and popular contention."

This presentation of the case describes precisely the difficulty under which all discussions on the tariff question in this country have hitherto labored. We believe, however, the difficulty in agreeing upon a common basis is one of inability rather than one of unwillingness; for, where facts are contradictory, how is it possible to establish a common basis? The advocates of two opposite and distinctly contradictory theories can scarcely be expected to find a common basis of fact in a collection of instances which favor both theories. In such a case it would be reasonable to suppose one of two things: either that the theories were *per se* insufficient to account for the given effect, or that they were

* Inventional Geometry. D. Appleton & Co., New York.

totally unfounded. The champions of both free trade and protection have hitherto waged their combats clothed in mail. Their swords have been of lead; their lances, wood. And, like the modern French duels, no lives have been lost and no blood shed. Hence the duration of the contest; hence its fruitlessness. Tariff discussions have been conducted on the assumption that the prosperity of trade was due to one of two systems. Instead of working from effect to cause, the cause has been assumed, and the struggle has been an endeavor to reconcile given facts with given theories. Hitherto it has been a drawn battle. As often as the advocates of commercial restriction have laid claim to those periods of national prosperity when their system happened to be in vogue as evidence of its success, the free-traders have as often and with equal right claimed like success under eras of free trade. And when these have associated times of commercial depression with the protective system, their opponents have retorted by instancing years in which free trade was accompanied with panics and business stagnation. The high-tariff periods of 1824 to 1833 and 1842 to 1846 are offset by the low-tariff period of 1846 to 1856, and the panic of 1857 by that of 1873. The growth of the iron industry under protection is balanced by the death of the shipbuilding industry during the same time. With such instances, gathered from a century's experience, the cause of the duration of this contest—which threatens to be perpetual—becomes apparent when we consider the lines along which the battle has hitherto been conducted. In England it was conducted somewhat differently, hence the results were different. There the leaders fought with sterner weapons, and the fight was fought to a finish. The difference between the English free-traders and the so-called free-traders of the United States consists in the former professing what their name indicates. They have followed their theory to its logical conclusion. The latter, however, have always stopped short of absolute free trade. Often, in fact, the dispute on this side of the Atlantic has been nothing more than one of "tweedle-dee" and "tweedle-dum." Instead of a difference of principle, it has generally been one of percentages. We think the fruitlessness of these controversies has been due principally to the method of reasoning employed. Both sides have used the same arguments, and both have been equally effective. Both parties have rested their claims on the teachings of experience, and both have drawn equal encouragement from similar results. It becomes evident that so long as this position is maintained, so long the discussion will remain in *statu quo ante bellum.*

Recently, attention has been called to a renewal of the combat, and the occasion has received more than ordinary attention, owing to the great distinction of the combatants. Indeed, it is doubtful whether at any time in the nation's history there has been so deep and general an interest felt in the subject as exists to-day. The chief feature in the renewed controversy is in the presentation of the free-trade argument from the English standpoint, and the method of reasoning there employed, with that used by the distinguished advocate of protection, which is so familiar to us. We shall endeavor to show that the former is the only method by which a satisfactory and truthful result can be obtained in any discussion regarding a subject of so complex a nature as trade. No word more aptly describes the nature of the Gladstone-Blaine controversy than "duel." The nature of the dispute necessitates direct antagonism. Free trade and protection stand directly opposed to each other. Like similar poles of a magnet, they are mutually repellent. They stand as much opposed to each other as virtue and vice. There are no grounds, nor can there be, for any compromise. One is freedom, the other restraint. The one recognizes a natural, the other an artificial law. If one is right, the other is wrong. The combatants in the recent contest are champions of their respective schools. Both were well equipped for the encounter, and each side has undoubtedly had the best words possible spoken in its behalf. Especially is this true in the article for protection. No abler advocate of the system could have been chosen. Moreover, this duel means more to Mr. Blaine and the Republican party than a mere intellectual contest. Far beyond any literary value the discussion may possess lies its political significance. A great political battle has been recently fought on this very issue, and, unless our prophets and wiseacres completely err, the presidential election of 1892 will occupy the same battle-field. Every incentive that pride and ambition can furnish conspired to urge Mr. Blaine to endeavor, to the best of his ability, to successfully refute his opponent's arguments and put him utterly to rout, even though he appear in the person of so illustrious and respected a man as the English ex-premier.

In any dispute arising between freedom on the one hand and restriction on the other, the burden of proof necessarily falls upon the advocate of restriction. Freedom is first in the order of things. Restriction is an innovation, and should explain its *raison d'être*. It would be sufficient for the free-trader to deny the advantages claimed for the protective system, and leave its advocate to prove his case. Mr. Gladstone has, however, gone further, and has not only given a general denial, but, by a series of arguments as brilliant as they are logical, demonstrated the superior advantages that flow from free trade.

The nature of the succeeding remarks finds its apology in the absence of anything like logic in the disquisitions of modern political writers. When so great an authority as the acknowledged leader of the Republican party is willing to risk his cause on arguments such as those contained in his recent magazine article; when the President of the nation seriously and deliberately tells the country that the import duties levied on commodities are paid not by the consumer, but by the foreign producer; when, in spite of the warnings given by the numerous and almost continuous series of labor troubles that have taken place for some years past, congressional orators assure themselves that wages are high and the working classes in a very satisfactory condition; when, in order to create a profitable trade, a party proposes to subsidize ocean steamships to do what they otherwise find it unprofitable to do—it would seem that the greatest need of the day was a compulsory system of instruction in dialectics, with a view more especially to impress on the mind of legislators the relations between cause and effect.

The two methods of reasoning employed in this discussion appear in marked contrast to each other, and it is interesting to see how their advocates are led to conclusions directly opposite. Vulgarly speaking, it is the school of Aristotle opposed to that of Bacon.

Mr. Gladstone deduces his results from general truths. Mr. Blaine arrives at his conclusions by induction. These two methods, known as the method of syllogism and that of induction, have been practiced by mankind in all ages, before the days when reasoning became an art and logic a science. Both may be employed with safety where practicable, and both will lead to the detection of truth, if properly carried out.* Induction is used in discovery, syllogism in verification. The latter begins where the former ends. Induction requires both patience and skill, and, if ill performed, will as assuredly lead to error as to truth when well performed. Both are constantly used by those who never heard of a major or a minor premise, of *comparentiæ* or *rejectiones*. The man who, learning that alcohol is poisonous, refuses to drink whisky, reasons by the method of syllogism. Likewise, the man

* "We shall find that in the study of moral philosophy, as in the study of all subjects not yet raised to sciences, there are not only two methods, but that each method leads to different consequences. If we proceed by induction, we arrive at one conclusion; if we proceed by deduction, we arrive at another. This difference in the results is always a proof that the subject in which the difference exists is not yet capable of scientific treatment, and that some preliminary difficulties have to be removed before it can pass from the empirical stage into the scientific one. As soon as those difficulties are got rid of the results obtained by induction will correspond with those obtained by deduction, supposing, of course, that both lines of argument are fairly managed. In such cases it will be of no importance whether we reason from particulars to generals or from generals to particulars. Either plan will yield the same consequences, and this agreement between the consequences proves that our investigation is, properly speaking, scientific." (Buckle's History of Civilization, vol. ii, p. 337.)

who carries an umbrella on a cloudy day does so from reasoning by the method of induction. In the former, having given our premises, we at once deduce a conclusion, and our only care is to see that our premises are correct. The inductive method is a far more elaborate and hazardous proceeding, and can only achieve success where patiently and exhaustively carried out. Its operation is thus described: "It requires an exhaustive enumeration of instances in which the given complex effect is present, in which it is not present, and in which it is present in various degrees or amounts. By the process of exclusion or elimination we may discover a phenomenon, constantly present when the effect is present, absent whenever the effect is absent, and varying in degree with the effect." The danger to avoid is an insufficient enumeration of instances. It is this danger that causes such popular delusions as "that it is unlucky to start a voyage on a Friday," or "that for thirteen to sit at a table betokens ill." Macaulay tells of a judge who was in the habit of propounding a theory that the cause of Jacobinism was the bearing of three names, and then demonstrating it by the rules of induction. Not long since a writer in one of the periodicals, noticing that the great majority of the Presidents of the United States bore but two names, warned the Republican party against nominating a man for the Presidency who had more! There is no proposition under heaven, however monstrous, which may not be reasoned out by the inductive method when so applied.* It led Henry C. Carey to say that "the material prosperity of this country could be more fully promoted by a ten years' war with Great Britain than it could be in any other way." It will be seen at once wherein the difference between this induction and that which led Newton to the discovery of the law of gravitation consists. The difference is not in the kind, but in the number of instances. Let there be but one instance in which a heavy body having been projected upward failed to return to the ground, and away goes the stability of Mr. Newton's theory. If the believer in the superstition of the number thirteen will make a few experiments, he will very soon relieve himself of his delusion; and had the sagacious writer reasoned properly, he would have found the names of John Quincy Adams and Ulysses S. Grant ample material with which to annihilate his theory. A further difficulty in the application of the inductive method consists in the existence of a multiplicity of causes, and the impossibility often of discovering and separating them. Social problems are affected by causes so numerous and so complex that their detection and distinction are frequently impossible; and until we know what they are, can we do more than state that such and

* "Every man who has ever reasoned on this subject has always *proved his theory, whatever it was, by facts and calculations.*" (Hume's Essay on Balance of Trade.)

such a result is produced by a variety of causes, some of which may be known and some unknown? But as to what particular cause the effect is mainly due, and to what degree others influenced the result, we have no better means of knowing than the astronomer has of understanding the cause of the variation in the moon's orbit, when he is ignorant of the Newtonian laws. The sick man, having dosed himself with a variety of drugs and suddenly finding himself restored to health, has no reason for claiming that this or that particular compound had the salutary effect, if his knowledge is limited to this one or similar experiments; and so long as we fail to discover instances in which the disturbing causes are absent, or in which they can be eliminated, so long the method of induction remains useless. The problem of trade is an example at hand. Mr. Blaine informs us that trade is affected by a multitude of causes, such as locality, the age and population of a country, wars—both domestic and foreign—by emigration, pestilence, and famine. He states that "the unknown quantities are so many that a problem in trade or agriculture can never have an absolute answer in advance." "If," he says, "the inductive method of reasoning may be trusted, we certainly have a logical basis of conclusion in the facts here detailed. And by what other mode of reasoning can we safely proceed in this field of controversy?"* What, indeed! And does Mr. Blaine really think it safe procedure to undertake the solution of a problem by a method the success of which is absolutely dependent upon a knowledge of all the quantities that are involved, when, as he states, the unknown quantities are so many? The truth is—and it evidently dawned upon him when he asked that question—the method of inductive reasoning can not be applied successfully in this discussion.† The

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* It would appear from this remark that Mr. Blaine is ignorant of one of the greatest—if not the greatest—works on political economy, The Wealth of Nations, which was reasoned cut entirely from general principles. Statistics—in the teachings of which Adam Smith placed little confidence—were used only by way of illustration, and were selected to suit the particular occasion. In his admirable chapter on the Scotch intellect of the eighteenth century, Buckle says: "If Hume had followed the Baconian scheme . . . . he would hardly have written one of his works. Certainly, his economical views would never have appeared, *since political economy is as essentially a deductive science as geometry itself*. . . . The same dislike to make the facts of trade the basis of the science of trade was displayed by Adam Smith, who expresses his want of confidence in statistics, or, as it was then called, political arithmetic. . . . It is no exaggeration to say that if all the commercial and historical facts in the Wealth of Nations were false, the book would still remain, and its conclusions would hold equally good, though they would be less attractive. In it everything depends on general principles, and they, as we have seen, were arrived at in 1752—that is, twenty-four years before the work was published in which those principles were applied." (History of Civilization, vol. ii.)

It is a singular fact that neither Hume nor Smith were acquainted with trade practically, although masters of its science.

† "It is, however, evident that statistical facts are as good as any other facts, and, owing

problem before him is to show that the system of commercial restriction has been a greater source of wealth for the United States than free trade would have been.*

He goes at once to the experience of the country and selects the following instances for examination: The high protective periods of 1812 to 1816, 1824 to 1833, 1842 to 1846, and 1861 to the present time; the partially protected period of 1833 to 1842 and the free-trade periods of 1816 to 1824 and 1846 to 1861. Here are seven instances, in four of which the effect is present, in one partially present, and in two absent. Now, assuming that all causes but one be eliminated, and assuming that one to be protection, the first four periods should be marked by the production of great wealth, the fifth by the production of moderate wealth, and the last two by the production of the least—or even by the loss of—wealth, calculated, of course, on a time basis such as per annum. Now, what do we find? Assuming that Mr. Blaine's rapid and cursory summary of those periods is correct, we learn that during the first-named period the country was sustained through a war, and that genuine prosperity characterized the other three mentioned high-protected periods, excepting that from 1873 to 1879, in which the business of the country was prostrated and the panic of 1873 ensued. We further learn that the partially protected period of 1833 was very disastrous to trade, resulting in the panic of 1837, and that that of 1816 to 1824 was equally disastrous, while the greater part of the free-trade period of 1846 to 1861 was characterized by the greatest prosperity. Here, then, we find prosperity under a high protective system and prosperity during a free-trade era. Similarly, we find disaster under high protection, disaster under low protection, and disaster under free trade; and from this confusion Mr. Blaine mildly tells us he has proved his case, and by the great method of Bacon too! Could anything be further from the truth? If his argument proves anything at

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to their mathematical form, are very precise. But when they concern human actions they are the result of all the motives which govern those actions; in other words, they are the result not merely of selfishness, but also of sympathy. And as Adam Smith, in the Wealth of Nations, dealt with only one of those passions—viz., selfishness—he would have found it impossible to conduct his generalization from statistics, which are necessarily collected from the products of both passions. Such statistical facts were in their origin too complex to be generalized, especially as they could not be experimented upon, but could only be observed and arranged. Adam Smith, perceiving them to be unmanageable, very properly rejected them as the basis of his science." (Buckle's History of Civilization, vol. ii, p. 367.)

* It is strange how the disputants who have succeeded Mr. Blaine in this controversy seem to lose sight of the main issue. No one can deny the facts which these gentlemen unceasingly proclaim, viz., that the creation of wealth, and the growth of the manufacturing industries of the nation during the enforcement of protective laws, have been prodigious. But not one writer has offered the slightest particle of evidence to show that a greater advance would not have been made under a system of free trade.

all, it proves that tariff legislation, taken separately, had no more influence on the national prosperity than the movement of the planets. To make matters even worse, he attempts to account for the instances that make against him by ascribing the results to other causes. For example, in the case of the free-trade period, 1846 to 1856, he tells us that the war with Mexico, the Irish famine, the discovery of gold in California, and the Crimean war combined to defeat the natural result of free trade, and, instead of there being a minus, there was a plus quantity. What else is this than a simple begging of the question ? By assuming that the result was due in this instance to a plurality of causes, sufficiently strong to totally destroy and even reverse the effect which he believes free trade would have produced alone, he leaves the ground open for a similar assumption by his opponents during those periods which apparently make for his theory. Wars, famines, and gold discoveries have happened at other times—times in which protection was in force. These would doubtless produce similar effects in disturbing the predicted results, and would act as disastrously against Mr. Blaine's theory in the one instance as for it in the other. It was of reasoning such as this of which Bacon wrote : "The very form of induction that has been used by logicians in the collection of their instances is a weak and useless thing. It is a mere enumeration of a few known facts, makes no use of exclusions or rejections, concludes precariously, and is always liable to be overthrown by negative instances." *

For a satisfactory and anything approaching a reliable application of empiricism, it would be requisite to ascertain precisely what effect the increase of population, emigration, the variations of the seasons—causing excessive rains, droughts, and storms—also inventions, political contests, fires, robberies, etc., had upon trade; and until such an application can be made, no one can truly say such and such a period of prosperity was due directly to the tariff. The element of time plays one of the most important parts in this method.† Our greatest and most general truths have taken ages to make themselves apparent. We come now to the examination of the argument by which free trade is sustained.

Mr. Gladstone deduces his conclusion from these premises: "International commerce is based not upon arbitrary or fanciful considerations, but upon the unequal distribution among men and regions of aptitudes to produce the general commodities

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* The inductive system seems to have been the peculiar aversion of the brightest Scotch intellects of the eighteenth century. Both Adam Smith and David Hume spoke contemptuously of the Baconian method, and Buckle thinks this aversion to Bacon's system led Hume to underrate his genius. In his History of England, Hume places Bacon inferior to Galileo, and possibly below Keppler! which Buckle considers unfair.

† Hume calls it the "tedious, lingering method." (Philos. Works, vol. i, p. 8.)

which are necessary or useful for the sustenance, comfort, and advantage of human life." There can be no dispute on this point. It is a self-evident truth. Aristotle tells us that he who rejects self-evident truths has no surer foundation on which to build. It follows, as a natural conclusion, that whatever interferes with or checks the natural flow of goods and commodities from one region to another, and from one class of men to another, is a decided loss to both classes. "If," adds Mr. Gladstone, "every country produced all commodities with exactly the same degree of facility or cheapness, it would be contrary to common sense to incur the charge of sending them from one country to another."

It has been the aim of protective legislation to offset those special aptitudes of production which foreign nations possess by artificial barriers. Such legislative acts have constituted, virtually, a leveling process whereby the natural flow of trade has been stopped. This has necessarily been attended with expense and loss of wealth. The premises may be stated in a different way. Since trade produces wealth, whatever increases trade increases wealth, and that which restricts trade restricts the production of wealth. Protection is restriction. Hence, protection hinders the production of wealth. It may be varied in another way: The growth of wealth is proportional to the growth of trade, and the growth of trade is proportional to its freedom from restraint. Hence the growth of wealth is proportional to the freedom which trade enjoys. Similarly, that monstrous statement that "protection does not tend to keep up prices" may be thus exploded; by stating the fact that free competition tends to reduce prices, and that protection hinders free competition. Ergo, protection hinders the reduction of prices. The premises here laid down are as self-evident as any truths regarding trade can be. In fact, they are contained in the definition of the words "free trade" and "protection" themselves. The protectionists have admitted them again and again, but yet so blinded have they become by their own method of induction, that they have been prevented from following out what reason dictates. The question is analogous to that of slavery. It was an argument used repeatedly during the Southern dispute that the slaves were better off under the slave trade. Numerous instances were given where the slave preferred to remain in slavery than to accept his freedom. Nevertheless, the question was decided on general principles, and the moral course has proved the economical one.

The party of protection, instancing the growth of the United States during the last quarter century—corresponding with the operation of the Morrill Tariff Act—challenges comparison with any period of equal duration in the world's history. It is doubtful if history *could* show any period which would stand comparison—so far as the amount of material wealth created during so short a term is concerned. Nevertheless, if this be so, it must not be forgotten that there have never been in the history of the world such gigantic forces at work, nor so rich and varied a field for their operation. If, instead of standing awe-stricken at the vastness of the results, we contemplate the magnitude and proportion of the original factors, we shall cease to marvel. Remembering the immense area of the country, the fertility of its soil, the number and riches of its mines, the number and navigability of its rivers, the availability and inexhaustibility of its fuel; remembering the amount of available labor, both human and mechanical—the latter representing hundreds of millions of human arms, and the former increased by supplies drawn from the Old World to the extent, also, of millions; remembering the number and utility of mechanical inventions designed to assist in the production of wealth; and bearing in mind that during this period the country has been free from war, that she has had to keep neither navy nor standing army—when we contemplate all this, instead of losing our mental balance, we shall most probably feel a sense of disappointment that the results are not even greater. If it were possible to estimate the original factors in the production of wealth as they have here existed during the last twenty-five years and calculate the product that should naturally follow, we should more than likely find it greatly in excess of that now existing.

Who can estimate the influence of inventions alone? It is supposed that England to-day uses, in steam-power only, a force equal to an army of eight hundred millions of men in the production and transmission of commodities. These, bear in mind, are men of iron, who never flag so long as fuel is supplied, who never grow weary, who never strike, who work as readily twenty-four hours per day as ten, and whose cost of maintenance is infinitesimal in comparison to that of men of flesh and blood.

There was invented in the latter part of the eighteenth century a machine that has done more for producing wealth than all the acts for fostering trade and developing industries that were ever devised by man. Eli Whitney has done more for the prosperity of his country than all the tariff discussions before or since his time. The supremacy of England in trade and commerce throughout the world is due more to Watt and Arkwright, to Stevenson and Crompton, than to either Walpole, Pitt, or Peel. Mr. Edison is a greater force in the national prosperity than all the measures for the encouragement of trade passed by Congress during his life-time. The beneficial influence inventions have had on civilization is only comparable to the evil that war and pernicious legislation have achieved.

The early history of the colonies furnishes, we think, a remarkable illustration of what can be done without the fostering care and protection of a paternal government. In 1606 there was not a single English-speaking person in this country. A century later a colony had sprung up numbering one million souls, with industries established that bid fair to outrival those of England. In 1760 the population exceeded one quarter the entire population of England and Wales. Ships were being built and sent to England. The ship-carpenters of Great Britain petitioned Parliament to suppress an industry that threatened to supplant their own. The wool manufacturers became alarmed as they found the colonists rapidly acquiring their trade. Bar iron was manufactured and shipped to England cheaper than that from Sweden. The hat industry developed in the face of English rivalry. In 1700 the total exports amounted to $1,919,700, in 1730 it was $2,789,640, and in 1760 it had grown to be $3,698,460. And all this was in spite of acts of Parliament designed to cripple the colonial trade and ruin its industries. Act after act was passed, forbidding any one engaging in various manufactures under severe penalties. At this time England was, as Mr. Blaine says, not only severely but cruelly protective. Notwithstanding all this, the colonial trade grew and prospered, and England felt that she had a keen competitor in many of the manufactures in which she had hitherto considered herself supreme. Surely we have here an answer to those who ask "what industries would to-day be existing but for the great system of protection?" We present this period, commencing from the arrival of the first colonist and extending to the outbreak of the Revolution, and leave our high-tariff friends to reconcile its teachings with their remarkable theories—if they can. One advantage, it will be noticed, has accrued to the free-trade party by the recent controversy. It appears in the form of an admission. Mr. Blaine admits—with a certain degree of caution—that an insistence on the application of protection to all countries as the wisest policy would be erroneous. He says: "Were I to assume that protection is in all countries and under all circumstances the wisest policy, I should be guilty of an error." This will play sad havoc with our friends, the protectionist optimists, who hold their system, as Mr. Gladstone says, "to be an economical good"—good for all lands, all ages, and all people. But why does Mr. Blaine *not* insist on the universal application of his theory? On what reasonable grounds does he restrict its field of operation? Science teaches us that the more applicable a theory becomes, the nearer it approaches universality, the more certain may we be of its truth; and, conversely, the less applicable it becomes as its territory enlarges, the more its incorrectness is exposed. The free-trader recognizes this law and refuses to restrict his system by any artificial boundaries. He strikes at once at the root of the subject. He sees that trade finds its basis not in any system of legislation, but in human wants and desires. Wants lead to industries, and industries to commerce. One form of production necessitates another. Food, clothing, and shelter are requisite to mankind in all parts of the globe. Climate, soil, and topography determine only the *kind* requisite. Mr. Blaine considers the universal application of Mr. Gladstone's theory as a "most remarkable feature." It would have been a much more remarkable feature had he restricted it. The "feature" which the protectionist does not seem to understand is that free trade is not simply a "theory" any more than human freedom is. Both are moral truths. And just as Mr. Blaine believed in loosening the shackles that held the slave in bondage, so the free-trader believes in throwing off all the fetters that hold trade in check. Similarly, as he would denounce him who held human freedom to be a policy—wise only under certain conditions and in certain countries—so the free-trader feels Mr. Blaine's suggestion to be equally absurd and immoral. Free trade is not a mere policy. It is based upon the "live-and-let-live" principle, and the highest testimony to its wisdom, as well as its truth, is its universal applicability. It recognizes neither religion, color, language, nor climate, and is limited only by human existence. It is at this point that the ethical side of the question may well receive notice. To Mr. Blaine it appears amusing that his opponent should see any question of ethics in the subject at all. We believe that to most people the strongest feature in the slave question was its appeal to the moral sentiment. It was certainly this phase that inspired the most eloquent appeals and the greatest oratorical efforts. Similarly, it is this same sentiment that animates the mind of Mr. Gladstone. The idea is expressed by Herbert Spencer as follows: "The ability to exercise the faculties, the total denial of which causes death—that liberty to pursue the objects of desire, without which there can not be complete life—that freedom of action which his nature prompts every individual to claim, and on which equity puts no limit save the like freedom of action of other individuals, involves, among other corollaries, freedom of exchange. Government—which, in protecting citizens from murder, robbery, assault, or other aggression, shows us that it has all essential function of securing to each this free exercise of faculties within the assigned limits—is called on, in the due discharge of its function, to maintain this freedom of exchange, and can not abrogate it without reversing its function and becoming aggressor instead of protector. Thus, absolute morality would all along have shown in what direction legislation should tend. . . . An enormous amount of suffering would have been prevented; that prosperity which we now enjoy would have commenced much sooner; and our present condition would have been one of far greater power, wealth, happiness, and morality. . . . *The moral course proves to be the politic one.*" *

HABITS OF THE BOX TORTOISE.

By ALFRED GOLDSBOROUGH MAYER, M. E.

WITH DRAWINGS BY THE AUTHOR.

WHO has not been charmed by the many quaint and interesting narratives of the habits of animals, left to us by that father of English natural history Gilbert White? The philosopher vicar, far from the troubled world, among the peaceful beauties of Selborne, devoted a long life to the study of nature. Among his favorite pets was "the old tortoise" named Timothy; and many a letter to the Honorable Daines Barrington gives minute and careful descriptions of its peculiar actions and intelligence. There is a joyful ring in the old gentleman's tone when he finds the tortoise "distinguishes the hand that feeds it, and is touched with the feelings of gratitude"; again, we find him lost in wonder at its extreme old age; or marveling that an animal so completely protected should have such fear of rain as to crowd against the stone wall and close itself up. Then the vicar's head bows sadly, with the air of a melancholy Jacques, as he watches his pet's amorous wanderings in early summer.

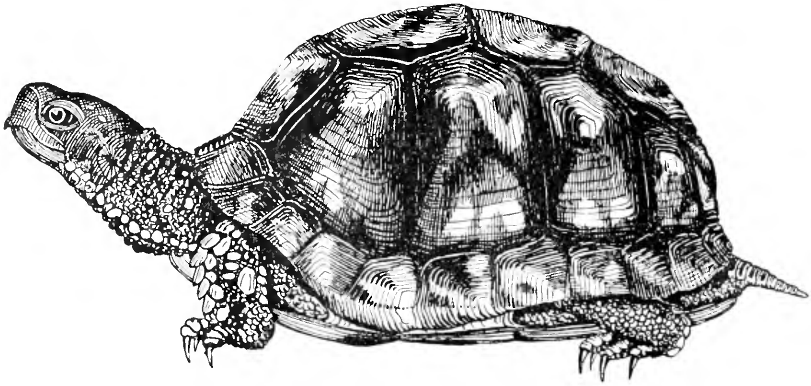

Fig. 1.—The Box Tortoise. (Side view.)

In America we also have a land tortoise, whose ways and modes of life are quite as interesting as those of White's Timothy. It is a little creature not more than five and a half inches long when full grown. No two individuals are marked alike. Before

* Essays: Moral, Political, and Æsthetic.

the attainment of full growth the shell is corrugated by numerous concentric ridges. As a new one is formed every year, the age of the tortoise may be obtained by counting these ridges, provided it be not full grown; for in old age the shell becomes smooth and polished. Some are of a brownish horn color streaked with rich yellow, others are black covered with oval yellow spots. The color of the legs and head varies from dark brown to bright yellow. Frequently the old males have blood-red eyes, which give them a ferocious appearance.

The box tortoise is most commonly to be met with in shady places, near the borders of woods; or near damp or marshy ground, where worms and insects abound. The tortoise has quite an aversion for wet places, and, although it is a fairly good swimmer, and can remain for over twelve hours beneath the surface without once coming out to breathe, it is rarely to be found in the water. In May and early summer it deserts the shade of the woods where it has spent the winter, and moves into the open meadows, where the fresh young grass is becoming thick and high, myriads of insects are waking into life, and the wild strawberries are beginning to redden. After the pastures are mowed in July the tortoises scatter, some remaining in the meadows, others taking again to the woods. For this reason the animal is much more rarely met with in August than in June.

Owing to the extreme slowness and deliberation of all its movements, it seems wonderful that it can obtain enough to eat. Often it will hesitate for a full minute, on finding an insect, before summoning up enough resolution to seize it. The neck is slowly stretched forward, the jaws open and close upon the victim, and the head is immediately snapped back as though frightened at what it had done. Deglutition is accomplished by a series of gulping movements, which often cause a squealing sound. Its food consists of crickets, grasshoppers, caterpillars, worms, and, in fact, almost any luckless insect which it may find. It is very partial to wild strawberries, tomatoes, and many fungi. There can be no doubt that it greatly aids the farmer by destroying the larvæ of injurious insects. In seeking its food the tortoise wanders about in the most zigzag courses imaginable. A whole day's wanderings, of over half a mile, may not cover more than a quarter of an acre. Our little friend rarely wanders far from the place of his birth. In the month of May, 1880, a dozen tortoises found in a three-acre pasture were marked by the writer. Every year they return to the same meadow, so that in 1889 eight of them were identified. The most erratic individual was found half a mile from the meadow, six years after being marked. The tortoise is very generally distributed over the United States east of the Mississippi, but its local distribution is variable. In some sections it is very common, in others extremely rare. On the approach of the frost, about the middle of October, the tortoise burrows about a foot beneath the fallen leaves of the woods, or into soft, marshy ground, and there passes the winter in a torpid state. About the middle of April it digs its way upward again, and may be seen crawling slowly about, covered with caked and frozen mud.

But the most remarkable ability of the little reptile is his power to entirely withdraw himself within his shell, and then to close up the openings. Observing the approach of an enemy, he rapidly draws in his head, legs, and tail, giving expression to his displeasure by a sharp hiss; then, folding up the two flaps of the lower shell until they fit accurately into the cup-shaped edge of the upper, he becomes as unopenable as an oyster. In most cases the fit of the carapace and plastron is so perfect that it would be difficult to insert the head of a pin into any crack, and the muscles are so powerful as to render it well-nigh impossible to force an opening. Yet the jaguar of South America has been seen to tear open the shells of similarly protected tortoises. We may feel assured that the protection is a needed one, for it is very rare to find an old box tortoise whose shell does not show marks of rough usage.

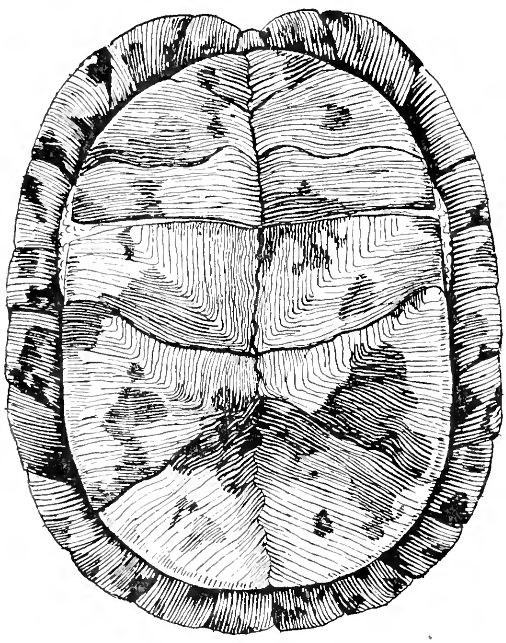

Fig. 2.—Under Side, showing Closed Shell.

There is a well-grounded popular belief that our tortoise lives to a vast age, and numerous cases of turtles bearing dates over a century old have been cited. There was, until 1886, in the neighborhood of the writer's home in New Jersey, an old tortoise which had been marked by Mr. Cyrus Durand, the inventor of the geometric lathe It bore the inscription "C. D. 1838," clearly cut with a graver, on its under shell. As the tortoise had been observed from year to year since the time of its marking by the most trustworthy witnesses, there can be no doubt that the date was gennine. This tortoise has not been seen since 1886, so it has probably died. Another, which has been observed for the past nine years, was marked with the inscription "C. B., 1849"; as the letters and date were so much worn as to be but faintly discernible, they were doubtless reliable. This old animal was found for the last time, dead, in the summer of 1889. Another, bearing the date 1851, is still alive. Assuming that the tortoises were full grown, or about twenty years old when marked, we are safe in stating the period of their lives as from sixty to seventy years. No doubt some individuals may reach a century or over. Unfortunately for science, it is a common sport for the country urchin to engrave tortoises with dates varying from forty to fifty years before the artist's birth. This, however, can almost always be detected, for the inscription becomes very faint after thirty years of rubbing over the ground. In fact, it would seem impossible that an inscription could last for a hundred years, as the growth of the shell and the constant friction would probably obliterate it.

The tenacity of life in all tortoises is remarkable The heart will continue to pulsate for over three quarters of an hour after being cut out of the body, and the animal is said to have lived for several months after the brain had been removed. There seems to be fully as much fat about the muscles of tortoises which have just awakened from the winter's sleep as there was in the preceding autumn. Doubtless they could remain torpid for over a twelvemonth, and then recover.

The mating season of our box tortoise occurs during the first three weeks in May. The males are unusually active during this period, and will fight savagely among themselves. The author was once fortunate enough to witness one of these combats. Two old males were facing one another; using the front flaps of their plastrons for shields, they would charge, snapping viciously, and whenever one obtained a grip he would hang on with bull-dog tenacity. The noise made by their shells knocking together could be heard two hundred feet away. After an hour or more the smaller male began to show signs of exhaustion, his charges became weaker and weaker, until finally he closed his shell tightly and refused to fight. The victor, after snapping at the unresponsive shell for a few moments, crawled deliberately over the back of his shut-up adversary. It was found upon examination that neither of the combatants had received any visible injury, so well did their armor of shells and scales protect them.

All turtles are oviparous, depositing their eggs in the ground and leaving them to be hatched by the heat of the sun. The laying period of our box tortoise extends from the 7th to the 20th of June. A few females lay in the autumn, but this seems to be a perverted instinct, and not a regular habit of the species. They always lay at night, and deposit all their eggs in a single nest. As soon as the sun goes down the female sets about her maternal duties. She wanders over the fields with restless activity until she finds a locality suitable for the formation of the nest. Stubble-fields, or those which, having been recently under cultivation, are covered with a thin growth of grass, are preferred. She then begins to scratch up the earth with her hind feet, using first one

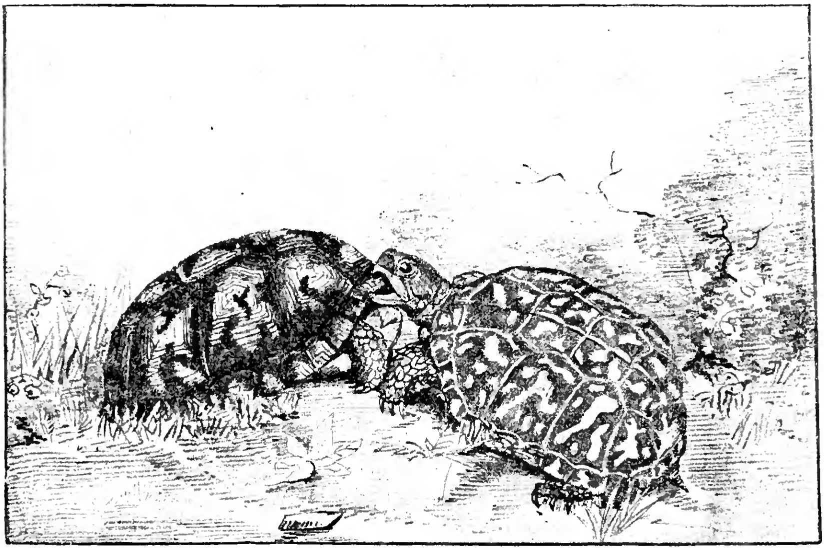

FIG. 3.—OLD MALES FIGHTING. Showing extreme variation in the coloring of the species. (From a sketch made at the time.)

and then the other. After about three hours of patient labor, a small hole about four inches in depth and two inches in diameter, a little wider at the bottom than at the top, has been excavated. An egg is then dropped into the cavity and carefully pushed against the side by the hind foot of the mother; another is then laid and placed in position as before, until from four to six eggs are ranged side by side in the bottom of the nest. The earth is then carefully scraped back by the hind feet, and finally the grass and leaves are scratched over the opening and pressed down so skillfully that the ground appears as though it had never been broken. By this time it is past midnight It is remarkable that the females do not seem to fear the presence of the observer, but continue their labors, although he may be but a foot or two away. When once started digging the nest they rarely abandon the work. We have observed a tortoise of another species (*Nanemys guttata*) which dug all night, and finally completed its nest on the noon of the day following.

The eggs are covered with a soft white calcareous shell. They are of an oval shape, 1·28 inch long and ·91 inch in diameter. When carefully blown they will retain their form. The shell is very hydroscopic, and, if the eggs be placed in alcohol or glycerin, they soon shrivel, owing to the abstraction of water from the interior. The young hatch late in October, just in time to move into winter quarters.

The disposition of our box tortoise is timid and gentle. If kept for a pet, it soon becomes very tame, and will eat from the hand of its master, whom it may even grow to recognize. In captivity it displays a great variety of tastes, and will readily take to cooked meat, vegetables, or bread.

Of all the lower vertebrates the tortoises exhibit, perhaps, the most marvelous regularity in their habits.

Thus the duration of the laying period is a very short time, usually in June, and rarely extending over two weeks for each species. It seems to be independent of the severity or mildness of the season, but occurs with wonderful regularity year after year. The same rule seems to apply to the time of hibernation. Seven young tortoises of various species, which were kept in an aquarium in a warm room, simultaneously refused to eat on the 5th of October, and went into hibernation just as they would have done if in the open air. They remained buried in the mud beneath the water, or huddled up asleep upon the land, and touched no food for over two months. Sometimes, when the aquarium was exposed to the full heat of the sun, one or two would awaken and crawl slowly about, but it was extremely difficult to induce them to eat.

A turtle's heart consists of two auricles and only one ventricle; so, the blood is never completely aërated and is therefore, comparatively speaking, "cold." This is the reason that tortoises, especially those species which inhabit our rivers and ponds, delight to bask for hours, exposed to the full glare of the hottest sun.

Millions of years ago, when marshes covered the greater part of the face of the earth, the reptiles were of huge size and strength. The turtles of to-day are but the pygmy descendants of these giant ancestors. Protected by their bony coverings, or relying upon their knife-like jaws and savage dispositions, they have survived in stunted form until to-day. Now, in this age of man, many species bid fair to outlive the wanton destruction which is fast depriving our woods and meadows of the wild creatures which once knew them as a safe retreat. The beaver, the gray squirrel, the wild pigeon, will soon be no more; but the lover of nature may still find our tortoise for his study and amusement.

THE HISTORY OF A STAR.

By J. NORMAN LOCKYER.

IT is now exactly thirty years since the world rang with one of those discoveries which go down to the ages and at once insure the names of the makers of them being inscribed upon the muster-roll of the immortals. In the autumn of 1859, Kirchhoff and Bunsen announced that at last a way had been found of studying the chemical nature of bodies in space—nay, more, that they had already begun the work, and found that the sun, at all events, was built up of matter identical with that of which the earth is composed.

In physical science in most cases a new discovery means that by some new idea, new instrument, or some new and better use of an old one, Nature has been wooed in some new way. In this case it was a question of a new idea and an old instrument. The instrument was the spectroscope.

It forms no part of my present purpose to deal either with the principles involved in spectrum analysis or its history during the period which has elapsed since 1859. The task I have set myself in this article is a much more modest one.

First, I wish to point out that during the thirty years the method of work which Kirchhoff and Bunsen applied to the sun has been applied to the whole host of heaven. By this I do not mean that every star has been examined, but that many examples of each great class—nebula, comet, star, planet—have been studied. The same kind of information has been obtained with respect to these bodies as Kirchhoff and Bunsen gleaned with regard to the sun; and the great generalization to which I have referred has been found to hold good *in the main* for all. From nebulæ and stars existing in space in regions so remote that the observations have been of the utmost difficulty in consequence of the feebleness of their light; from comets careering through stretches of space almost at our doors, the same story has come of substances existing in them which are familiar to us here. In ascending thus from the particular to the general, from the sun to the most distant worlds, it is obvious that the field of observation has been enormously extended. Kirchhoff and Bunsen's view has been abundantly verified, as we have seen; but the question remains, Has this larger area of observation supplied us with facts which enable us to make a more general statement than theirs? It is possible that it has. Recent inquiry has suggested that if the study of meteorites be conjoined with that of the heavenly bodies, the story told by the spectroscope enables us to go a step further, and to say that not only have we the same matter everywhere, but all celestial bodies, including the earth, are due to an exquisitely simple evolution of matter in the form of meteoritic dust. We have no longer to rest content with the *fact* that all nature is one chemically: we have the *cause.*

Secondly, I propose to make as short and simple a statement as I can of the general idea of the new cosmogony suggested by the spectroscopic survey to which I have referred.

I must, in the first place, ask my readers to grant me the scientific use of their imagination; and in order that it may not be called upon to cope with questions as to whether space is infinite or not, or whether space and time ever had a beginning, we will not consider the possibility of the beginning of things or attempt to define the totality of space, but we will in imagination clear a certain part of space and then set certain possibilities at work.

How much space shall we clear? A very good idea of one of the units of space which is very convenient for me to employ here —I mean the distance of the nearest star or one of the nearest stars—can be obtained by stating the time taken by light in performing the journey between the earth and the stars, knowing as we do that light travels one hundred and eighty-six thousand miles in a second. In the case of the nearest stars the time thus required is about three and a half years. With regard to the twelfth-magnitude stars, we find that in all probability the distance in their case is so great that light, instead of taking three and a half years, takes three thousand five hundred years to reach us.

The space included in a sphere with this radius will be sufficient for our purpose. The stars that we shall have to abolish for the purpose of this preliminary inquiry number something like six millions; the probability being that, if we consider the stars visible, not in the largest telescopes, but in those which are now considered of moderate dimensions, their numbers may be reckoned at something between thirty and fifty millions.

Imagine, then, this part of space cleared of all matter. We shall have a dark void, and the probability is that all that dark void will sooner or later, in consequence of conditions existing in other parts of space into which we have not inquired, be filled with some form of matter so fine that it is impossible to give it a chemical name.

Next we may imagine that this something without a chemical name may curdle into something which is more allied with our terrestrial chemistry, and the chances are, so far as we know, that that first substance will be either hydrogen itself or some substance seen in the spectrum of hydrogen or closely associated spectra.

It is just possible that at this point we enter the region of observation. In the nebulæ we are brought face to face with a substance (or substances) which, as far as our observations go, exists nowhere else except in the very hottest region of the sun that we can get at with our instruments. It is unknown here, and all attempts to match the spectrum by exposing terrestrial substances to the highest temperatures available in our laboratories have so far been unavailing. Both in sun and nebulæ this substance (or substances) is associated with hydrogen. This curdling process will go on until at length further condensation will take place, and instead of having simply the substance (or substances) to which I have referred, and hydrogen, we shall have an excess of hydrogen with an infinitely fine dust interspersed in it, which will go on condensing and condensing until at last we get dust of substances the existence of which is revealed to us in the spectra of bodies known to terrestrial chemistry; among these are magnesium, carbon, oxygen, iron, silicon, and sulphur.

This dust, fortunately for those interested in such inquiries as this, comes down to us in more condensed forms still, and it is in consequence of the messages which they bring from the heavens that I am engaged in writing this article. Not only have we *dust* falling, but large masses; magnificent specimens of meteorites which have fallen from the heavens at different times, some of them weighing tons, are open to our inquiries. Although, therefore, it is very difficult for us to collect the dust, it is perfectly easy to produce it by pulverizing any specimens of these meteorites that we choose into the finest powder. If we examine this dust spectroscopically, we find that, in addition to hydrogen, its chief constituents are magnesium, iron, carbon, silicon, oxygen, and sulphur.

I have, therefore, in this first sketch of a possible result of a process going on in our space-clearing at an early stage, not arrived at something that is unreal and merely the creation of the imagination, but something very definite indeed, which we can analyze and work with in our laboratories.

How it comes that this infinitely fine dust, finer probably than anything we can imagine, becomes at last, in the celestial spaces, agglomerated into meteoric irons and stones with which the earth is being continually bombarded, is one of the most interesting questions in the domain of science. Space is no niggard of this dust, for if we deal with agglomerations of it sufficient in quantity to give rise to the appearance of a "falling star" to the unaided eye, we know that the number of such masses which fall upon the earth every day exceeds twenty millions.

We have, then, the idea before us that, here and there in this space that we have cleared, we have initial curdling, as I have called it; we need not assume that these curdlings are uniform.

It is impossible with our present knowledge to suppose that at any prior stage of the history of the heavens gravitation did not exist. It is impossible, from what we know now, to suppose that even the finest form of matter which entered our clearing in space was not endowed with motion. Given this matter, its motion and gravitation, let us next see what must very quickly follow.

Gravitation will give us a formation of centers; we shall get a rotation (moment of momentum) due to the prior existence of motion and to this formation of centers; we shall eventually in that way get condensing masses of this curdled substance.

The moment we have these centers formed, gravitation again will give us the motion of exterior particles toward these centers, and the condensation in one part of space will necessarily be counterbalanced by a clearing in another, so that, if we suppose that the curdling was not uniform to begin with, the uniformity will be less and less as time and this action go on.

Let us imagine that here and there we have isolated eddies, and here and there in the larger aggregations of the dust—in the most enormous swarms we can imagine—we have also eddies; these eddies involved in the larger curdlings will be associated with the phenomena of the general system of which they form an insignificant part. These cosmical molecules aggregating in this way will be, to compare great things with small, like the invisible molecules of a gas. It is not too much to say, as Prof. George Darwin has recently shown, that we shall have in effect the whole mechanism of the kinetic theory of gases before us; but, instead of dealing with invisible gaseous particles, we shall have particles, large or small, of meteoric dust. The kinetic theory tells us that if we have encounters we must have a production of heat; if we have production of heat we must have the production of radiation, although, if the heat be insufficient, the radiation may not produce light enough to be visible to the human eye.

It is a remarkable thought that all these changes to which I have so far drawn attention may have been going on in different parts of space for æons without any visible trace of the action being possible to any kind of visual organs. I refer to this because it is right that I should point out here that Halley, who was one of the first to discuss the possible luminosity of sparse masses of matter in space, and Maupertuis, who followed him, both laid great stress upon it.* When, then, these encounters, which we may call *collisions*, take place, and when the heat due

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* "But not less wonderful are certain Luminous Spots or Patches, which discover themselves only by the Telescope, and appear to the naked Eye like small fixt Stars; but in reality are nothing else but the light coming from an extraordinary great space in the Ether; through which a lucid *Medium* is diffused, that shines with its own proper Lustre. This seems fully to reconcile that Difficulty which some have moved against the Description *Moses*

to the arrested motion of the particles coming together, and the accompanying light are produced, we must expect that that light will at first be very dim, and will require very considerable optical power to render it visible.

We may now consider some early results obtained in connection with this matter. Sir William Herschel, although not the first to examine into it, was the first to bring before us an idea of the magnificent spectacle which the heavens present to mankind, and he, without any difficulty, with his large instruments, began by dividing these dim bodies into nebulosities and nebulæ; the nebulosities extending over large spaces of the heavens, and being of very, very feeble luminosity.

When we pass from these we become acquainted with bodies which may be truly termed nebulæ, as opposed to nebulosities, and the most magnificent of these is that in Orion, which has recently been so grandly photographed by Mr. Common and Mr. Roberts, the latter using the intensifying action of four hours' exposure of the photographic plate, hereby revealing details that no human eye will ever see, thus demonstrating how true it is that these changes may go on for æons and æons, though the eye may never become acquainted with them.

There is a magnificent arrangement in the human eye which, though it invalidates it for some astronomical purposes, is convenient, because it enables us to go on using our eyes all our lives, whereas a prepared photographic plate can only be used once. By this arrangement, however long we look at an object, it does not appear brighter, but in the case of the photographic plate all the action upon it is totaled, so to speak, so that if the plate be exposed, say for two hours or sixty hours, we shall go on getting impressed upon it more and more of the unseen. Thus the nebula of Orion, as *seen*, is almost insignificant compared with the glorious object which the photographic plate portrays if the integrating power be allowed to go on for hours.

It seemed pretty obvious, since the light of such bodies is so dim that a large portion of it beats upon the earth and upon our eyes without having any effect upon either, that the temperature was low; and it seemed also that to test the idea that this luminosity might be produced, as I have suggested, by collisions of meteoric dust, the way was open for laboratory work.

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gives of the Creation, alleging that Light could not be created without the Sun. But in the following Instances the contrary is manifest; for some of these bright Spots discover no sign of a Star in the middle of them; and the irregular form of those that have, shews them not to proceed from the Illumination of a Central Body, since they have no Annual Parallax, they cannot fail to occupy Spaces immensely great, and perhaps not less than our whole Solar System. In all these so vast Spaces it should seem that there is a perpetual uninterrupted Day, which may furnish Matter of Speculation, as well to the curious Naturalist as to the Astronomer."—Edmund Halley, Philosophical Transactions, vol. xxix, p. 392.

Smash a meteorite, collect the dust, expose it to a low temperature; compare its spectrum with the spectrum of such a body as those we have been considering, and see by actual experiment if there is any similarity. This was done.

The result was almost identical. It seemed, therefore, that one had at last got to solid ground, and could go ahead. But how to go ahead in a scientific way? Naturally by developing the argument which had led us so far. Let us agree that the nebulæ are condensations of meteoritic dust, and see whether we are led to the true or the false by such a concession. Let us further grant that the condensations go on. What will happen next?

In certain regions of space the encounters—the collisions—will increase in number in consequence of the accumulation of meteoric dust in these regions; the temperature will, therefore, be higher and the light more intense.

Is there only one process by which the temperature can be increased? It did not take very long to recognize that there might possibly be three lines of action, each one of which would result in the production of a higher temperature. In the first place, moment of momentum—rotation—being at our disposal to start with, it was obvious, in virtue of mechanical laws, that as the condensation went on the rotation would be accelerated; the motions of the particles of dust in the reaction, so to speak, would be more violent; the collisions, therefore, would produce more smashes, and more heat, and therefore more light.

We should get a central system and surroundings, such as Mr. Roberts has recently photographed in the great nebula of Andromeda. The exposure he gave was four hours, and again this photograph brings us face to face with phenomena which will probably never be seen by the eye alone.

A central condensation, here and there fragments of spirals, and here and there dark gaps, are seen. These gaps were observed by Bond and others years ago, but it remained for Mr. Roberts to demonstrate to us that they are produced by the wonderful indraught action which we can now, by means of the photograph, see going on. We have a concentration toward the center, the dark gaps representing to us either the absence of matter or the presence of meteoritic dust in a region where it is all going the same way, and in which, therefore, there are no collisions. Here and there we get regions of great luminosity, and associated with the spirals we get obvious loci of encounters. External swarms are also seen which have been thought, with great probability, to belong to the system—smaller condensations partaking in the general motion of the whole. Here, then, we are in presence of one possible cause of increased temperature.

There is another. One of the early results obtained by Sir

William Herschel was, that it was a very common thing for double nebulæ to make their appearance in his gigantic telescope. Now, it is difficult for us to imagine that these double nebulæ, like their allied systems of stars, should not be in motion; and if we imagine a condition of things in which one swarm is going around a larger one in an elliptic orbit, and occasionally approaching it and mingling with it, we shall have at one part of the orbit the centers nearest together; so that a greater number of particles of meteoritic dust will be liable to encounters at this time than at others. Hence we shall get a cause of increased temperature of a *periodic kind;* there must be variable stars in the heavens—and there are.

As a third possible condition we have the known movement of these swarms of dust through space. If we take note of the known movements of the star which forms the center of our own system, we can learn that these movements may be gigantic. We know that the sun is traveling nearly half a million of miles every twenty-four hours toward a certain region; we know that other stars are moving so quickly that Sir Robert Ball has calculated that one among them would travel from London to Pekin in something like two minutes. We have, therefore, any amount of velocity. Now suppose that without the formation of either a single or a double system, such as we have considered—by the ordinary condensation of an initial single or initial double swarm—we have what we may call a "level crossing" at which two or more streams of meteoritic dust meet. There, of course, we shall have a tremendous cause of collisions. Have we such instances in the heavens? Again I appeal to Mr. Roberts's photographs of the Pleiades; we see in them four nebulæ which have been stated to surround four of the stars. But if we look at the nebulæ more carefully, we find that distinct stream-lines are seen in each in certain directions; we have interlacing, the meeting of these streams at some angle or other, and in each such region we have the locus of one of the chief stars.

This may be considered to be an irregular cause of a production of high temperature; but so long as such an action as that continues, an apparent star will be seen, distinct, of constant light, and not to be discriminated, without such photographs as these, from those stars which have been produced by more ordinary sequences connected with the more ordinary processes of condensation.

If, however, the above explanation be the true one, we should expect to find cases in which we may see such an action beginning or ending suddenly; the action will be less constant and durable —that is to say, the supply of these streams of meteoritic dust may not be continuous; it may be smaller, and then the effect will be produced during a much shorter period of time. In that case the light of the star will not last long. If the onrush of one stream upon another or a more regular swarm is sudden, we shall have a sudden blaze out of light; if the onrushing stream is short, the light will soon die; if it continues for some time, and reduces its quantity, the light will die out gradually. Or again, such a source of supply may fail by the complete passage of one stream through the other. In these ways we shall have various bodies in the heavens, suddenly or gradually increasing or decreasing their light quite irregularly, unlike those other bodies where we get a periodical variation in consequence of the revolution of one round the other. We shall have "new stars" appearing from time to time in the heavens, and they do.

Unfortunately, no photographs of these bodies to which I refer have been taken. Observations have been recorded, however, of their changing light. The changes can be easily explained upon this hypothesis, but, so far as I know, can not be explained upon any other.

In one case we had a known star (in Corona) suddenly blazing out from the ninth magnitude to the second, and almost as suddenly going down again. In another star (Nova Cygni) we had an outburst in a region which observation showed to be without a star, although I do not know whether any special observation of that region had been made for the existence of nebulæ. Suddenly in that part of the heavens a third-magnitude star blazed out; this took a very considerable time to die down, as compared to the first star, in Corona, and ultimately it got down to the tenth magnitude, and now telescopically it appears as a nebula.

As in condensing these swarms get hotter, they will get brighter as their volume decreases, and we shall pass from what we term nebulæ to what we term stars. It can not be too strongly insisted upon that chief among the new ideas introduced by the recent work is that a great many stars are not stars like the sun, but simply collections of meteorites, the particles of which may be probably thirty, forty, or fifty miles apart. Such eddies and systems, which are not simple, will vary in brightness. In the case of double nebulæ condensing we shall get, as I have already stated, a periodic variation in light; and here we have a simple explanation of the facts observed, and hitherto held to be mysterious, in a large number of variable stars. The "new" stars I have already referred to are also easily accounted for on the hypothesis of meteoric streams.

It may be asked, Why, considering the millions of bodies in motion capable by this hypothesis of producing them, are not "new stars" seen more frequently? The reply is simple: We, as a rule, deal with the clashing of small streams; the temperature does not generally exceed that of a comet, probably; and hence the action takes place invisibly to us. Photographic surveys of the heavens often repeated will doubtless give us more numerous records.

We now return to the regularly condensing swarms. In these the condensation will go on, and the temperature will rise until the loss by radiation equals the increase of temperature due to the fall of meteorites upon the continually condensing center. If we imagine a star to be condensed more and more by the fall of meteoritic material upon it, we shall arrive at a time in which, provided that the supply of material ceases, the increase of temperature of the star from that reason will also cease, and then will arise a condition of things in which the heat radiated from the star will be greater than the heat produced in the body of gas which is ultimately formed in consequence of the tremendous temperature caused by the continual fall of meteoritic matter toward the center.

If it be true that in the nebulæ we begin with meteoritic dust-particles far separate from each other, we must gradually get an increase of temperature so long as they approach nearer the center of the swarm by condensation; and so long as the heat produced by bombardment is in excess of the loss by radiation, the temperature will increase; but when the loss by radiation exceeds the gain by the bombardment we must get a reduction of temperature. A temperature curve like one of the arches of Westminster Bridge flattened at the top will illustrate this idea. We have on the left-hand arm of the curve those bodies in which we get a rise of temperature due to collisions and to condensation; along the top of the curve we have the gradual formation of a globe of gas; the gas begins to cool and gradually condenses, until at the lower end of the right-hand arm of the curve, as a result of the total action, we get the formation of a body like the earth.

Such a temperature curve has been provisionally divided into seven parts, and what has been done so far is to show that there are seven well-defined groups of bodies in space, which may be located, three on the rising part of the curve, one at the top, and three on the descending part; representatives of each of these groups have been classified and their spectra have been carefully studied. There is absolutely no difficulty whatever about placing all the celestial bodies which have been so observed by means of the spectroscope in one group or the other; and further, where the spectroscopic evidence is complete, there is again no difficulty in dividing these groups into species, just in the same way that the biologist deals with organic forms. This has already been done for one group, and in a very few years it will no doubt be done for more, so that here again we are definitely in the region of hard, detailed facts.

There are two or three points to consider with regard to the history of a system, so long as it is on the rising part of the curve. If we begin with globular condensations, such as those first described by Sir William Herschel, we shall get, soon after the initial stage, spiral and irregular intakes, and then these may in time give place to rings such as we are already familiar with in a member of our own system; I refer to the rings of Saturn. Other dust-swarms near which such a system passes will be attracted to it, and in addition to the initial revolving swarm and its intakes and rings, we shall have a new order of things introduced which we may term comets.

Now the whole history of cometic astronomy goes to show that no comet can enter such a system as ours without feeling the influence of the central system in a very remarkable way. We know from other considerations that the nucleus of such a body is simply a swarm of meteoritic dust-particles, large or small.

The tail is always produced in a direction opposite to that of the sun, and by some electrical energy, thermal energy, or what not; the result being that something is driven from the swarm of meteorites in a direction away from the sun. Further, the stuff, whatever it may be, thus repelled, is brought by the comet from outer space; for some of the short-period comets, those that never leave our system, after they have passed round the sun a few times, throw out no tail at all.

If this can be universally proved for all comets, this is what must happen: each central body will, by means of this energy, place, as it were, a cordon round itself, inside of which no such matter can remain as is thus driven off from comets and produces the phenomena of a tail; and if it be ever possible to state the chemical nature of a comet's tail, the particular substances repelled by this central energy will be known. It looks as if the tails may consist, to a large extent, of the gases which exist in meteorites, and which can be driven out of them at not very high temperatures. Seeing that these are thrown off with great velocity and shine through millions of miles in the depths of space, it is not likely that we are dealing with any such condensable substances as the vapors of iron, magnesium, or any other metal. This consideration may help us eventually in the chemistry of the *repelling* body.

These revolving dust-swarms, as they increase their temperature, will go through the same temperature changes as other non-revolving ones. The existence of comets drawn into our system from without, composed, like the nebulæ, of meteoritic dust, enables us to subject the view we are now considering to a very crucial test.

We know that the temperature of comets is increased, chiefly, it has been supposed, by tidal action, as they approach the sun; because such an action must make a considerable difference in the movements of the particles of the swarm nearer the sun, as compared to those farther away from it; we know, in any case, by their increased light, that the temperature of comets *does* increase considerably as the sun is approached. It has been shown that many of the phenomena presented by comets, which are acknowledged to be clouds of meteoritic particles in the solar system, are identical with those presented by nebulæ and stars in space; hence the hypothesis now under consideration, which affirms the nebulæ to be also clouds of meteoritic dust, is greatly strengthened. Indeed, if the facts had not been found to be as I have stated them, the hypothesis would have been worth nothing.

I should here add that the recent work has shown how right Schiaparelli was, when, in 1866, he stated that comets were nebulous masses drawn into the solar system.

The top of what we agreed to call the temperature curve may now be considered. We have dealt with the ascending arm of it, and referred to the groups I, II, and III. In these groups there was evidence to show that, under normal conditions, we were dealing with orders of celestial bodies in which the temperature was gradually increasing, in consequence of the continual nearing of the constituent meteorites in the swarm due to collisions and gravitation.

It may be convenient that I should very briefly give, even at the risk of being charged with repetition, a normal case carrying us up to the top of the curve. For that purpose we may content ourselves by considering those globular and elliptic nebulæ first recorded by Sir William Herschel in the last century. In these there is evidence of different stages of condensation; in one series first of all something which is hardly visible is noted, and the end of that series consists of a dim, diffused, globular mass. In another we pass from the minimum gradually into another form of condensation, in which the luminosity increases toward the center. In still another series the condensation toward the center goes as it were by jumps, so that finally what appears to be a nebulous star with a surrounding of very nearly equal density is seen. Passing from these forms we come to elliptic nebulæ, which doubtless indicate a further condensation of those forms which, in the first instance, are globular. We have already become familiar with a representative of these elliptic nebulæ in that of Andromeda, as it has been revealed to us by the magnificent photograph taken by Mr. Roberts. In connection with such an elliptic figure we often get clear indications of spirals.

A further condensation then will no doubt land us among *stars* having a peculiar and special spectrum; indeed, though they appear as stars in our telescopes, their spectrum closely resembles that of the nebula. Going still further—still increasing the condensation, still increasing the temperature—the region of stars properly so called is reached, until at last we find those which are represented at the top of the curve. These results have been arrived at by spectroscopic work, and the facts recorded have been the chemical changes which take place in these swarms as their temperature increases, from the most sparse condition at the bottom of the curve to the most condensed one at the top.

In the sparsest swarms, in the so-called nebulæ, and those which are so dim as to be with difficulty visible, indications are found of the so far unknown substance or substances to which I have referred at the beginning of this article, together with carbon and hydrogen, and, in all probability, magnesium, one of the most common metals in meteorites, which has a bright spectrum visible at a low temperature; though I should add that the visible presence of magnesium has recently been contested. Its visible presence or absence, however, is not of fundamental importance. As the temperature increases, we find carbon more abundant, and traces of manganese and lead, metals which volatilize at a low temperature.

The next greatest change that supervenes is the addition of more familiar indications of the metals magnesium, manganese, and sodium, while the spaces between the meteorites glow more intensely with the light of hydrogen and carbon, probably brought about by some electrical action. Here the sparseness is still so great that we have little to do with the absorption of light; we simply deal with incandescent vapors due to the high temperature brought about by collisions among the meteorites and to the glow of the gases between the meteorites. But although the particles of meteoritic dust are so far apart that there is no possibility of any obvious absorption of their light occurring at this stage, to any large extent, the story is soon changed, for, when real condensation begins, the light of the meteoritic dust itself is absorbed by the vapors produced at low temperatures which lie between each particle of dust and our eyes. The whole theory of absorption is dependent upon the fact that light must come from the light-source through a vapor which is cooler than the light-source itself.

Thus we get a clear indication that, when this stage is reached, the meteoritic dust is very much closer together, and is on this account capable of forming a background enabling us to see these light-absorption phenomena. Absorption of light by the vapors of substances known to exist in meteorites, such as manganese and lead, is the first to occur, and these absorption phenomena gradually preponderate, and indicate change from low to high temperature, till finally the main absorption of light is caused by hydrogen and iron. Toward the top of the curve we get hydrogen enormously developed. It seems that we deal with a greater and greater quantity of hydrogen as the temperature gets higher.

Side by side with this sequence in the case of stars, a similar one up to a certain point is noted in the comets. As a rule the temperature of comets is, as we should expect, very much below that reached by stars. There is, therefore, no overwhelming indication of light-absorption, and it is only in those which closely approach the sun that any indication of the absorption of light caused by the presence of iron vapor is to be seen. A comparison of the spectra observed gives a clear indication that the nature of comets and nebulæ, so far as the spectroscope can seize them, is very similar: the phenomena present themselves in the same order; a line common to both begins the story, and then bright carbon is found among the first substances indicated, and afterward absorption phenomena, produced by manganese and lead chiefly, it is supposed, are superadded.

After this cometary parenthesis I now return to consider the top of the temperature curve. I repeat that we have this sort of condition. The swarms, whether single or multiple in origin, have by collisions and gravity brought about the highest point of temperature which they can reach in consequence of these actions. Swarms of separate meteorites now give place to a globular mass of gas produced by their volatilization. It may be that this very high temperature may be produced, and this enormous globular mass of gas formed, long before all the meteorites and meteoritic dust in the parent swarm, or in that particular region of space, shall be absolutely condensed to the center; so that we see it is quite possible that this high temperature condition may last for a very long time. Hence the curve should be flat-topped—in all probability very flat—for, so far as the spectrum analysis of stars has gone at present, more than half of those which have been examined give us evidence of extremely high temperature. However that may be, it is easily to be understood that such a mass as that we are considering must be radiating with tremendous energy; for a time probably the heat which it receives by the collisions and condensation of the outer members of the parent swarm may be as great as the heat which it radiates, and under these conditions the average temperature of the gas will remain constant; but the moment the input is less than the output the mass of gas must cool, so that we have next to consider what will happen to a mass of gas cooling under these circumstances.

What will cool first? The outside. We know pretty well the chemical nature of the outside of the mass of gas we are dealing with; we are practically dealing with a cooling globe of which the exterior absorbing layers consist of hydrogen, iron, magnesium, and sodium. And now perhaps it will be obvious why I was anxious in this general statement to begin as near as I could at the beginning of things. It is only by going back in that way that it is possible to explain this enormous development of hydrogen in the hottest stars. We saw that first one or perhaps two unknown substances—together with hydrogen, carbon, magnesium, manganese, lead, and iron—wrote their record in the spectrum, and that finally hydrogen was present in excess in the hottest stars. By the phenomena of comets it has been demonstrated that the radiant energy of our sun, and therefore the radiant energy of all other masses of equal temperature to our sun, drives, in all probability, everything of the nature of a permanent gas, like hydrogen or carbon compounds, away from the center of the system. Thus we may possibly explain the absence of oxygen and carbon from the sun; but hydrogen is present. The unknown substance or substances are concerned in most of the actions which take place in the hottest parts of the sun, and they are always associated with hydrogen. In the atmospheres of the hottest stars, again, hydrogen is enormously developed. Now that hydrogen, we have reason to believe, can not have passed the cordon to which I referred. The only supposition is that it and the unknown substances have as such been produced by the dissociation of the chemical elements of which the meteoritic particles which have formed the star in the manner I have indicated are composed. Here, then, we have a series of facts which add very great probability to the idea which has been arrived at on other grounds, that the chemical elements themselves are forms of hydrogen, or have a common origin.

On the right-hand part of the temperature curve the hottest state of things is represented at the top and the coolest at the bottom, and we pass through groups IV, V, and VI. As the temperature runs down, the hydrogen gradually disappears; as this happens in a mass of gas, the temperature of which is gradually but constantly reduced, we can only suppose that it is used to form something else. We get *association* due to reduced temperature in the same way that we get *dissociation* due to increasing temperature. The sun is a star just about half-way down the descending side of the curve; we know on other grounds that the sun is cooling.

The next part of the story is this: with decreasing hydrogen we get gradually associated an increasing quantity of the metallic elements (group V), and subsequently of carbon; but now the carbon vapors are absorbing, they are not radiating—in other words, the spectrum includes dark bands instead of bright ones, as they were on the other side of the curve. The light of the star is gradually blotted out by an enormous quantity of carbon compounds in some form or other, till at last the star gets blood-red (group VI), and finally is lost to human ken. The solar atmosphere at present contains chiefly iron, calcium, and other similar metals, but the hydrogen is disappearing, and there is possibly the slightest trace of carbon, but that trace is so small as to be somewhat doubtful. The composition of the sun's atmosphere at present is, moreover, almost identical with that of a mixture of meteorites driven into vapor by a strong electric current, and, if we except hydrogen, there is scarcely a line of any importance in the spectrum of the one which is not represented in the spectrum of the other. Calcium, aluminium, iron, manganese, and certain lines of nickel and other substances, are present. By means of such experiments as this, the wonderfully close connection between the gases at present existing in the atmosphere of the sun and the gases obtained from the volatilization of meteorites is put before us in the clearest and most convincing manner.

With regard to the fact that carbon comes in and takes the place of highest importance in the atmospheres of these cooling bodies, it is worth while to remark that if, as seems possible, these permanent gaseous compounds of carbon with different substances like oxygen, nitrogen, and hydrogen, and probably hydrogen itself, are kept away from the swarm during its condensation by that form of radiant energy of the center which is evidenced in the case of the sun by its tail-producing action on comets, it is easy to imagine that when that radiant energy is reduced, the carbon compounds will gradually approach the central body, until at length the flickering energy is no longer able to keep these permanent gases away, and then the surroundings of the central body are invaded by these gases in such tremendous quantity that an absorption is produced which first turns the cooler star blood-red, and finally blots it out.

There are several very interesting questions connected with this. Suppose, for instance, that we attempt to discuss the future of that magnificent nebula in Andromeda, the true structure of which Mr. Roberts has recently revealed to us. It is already suspected that the two subsidiary swarms partake of the motion and form a part of the system. Those smaller swarms will naturally condense before the larger ones. Let us imagine ourselves no longer dealing with anything so far away, but with the solar system when it was in that stage. The central sun having this cordon round it can only be formed of those substances which are not repelled by its radiant energy; it will, therefore, be chiefly a mass of metallic vapor. The masses near it for the same reason will be also chiefly of metallic vapors, and their density will be high;

those farther away will be less metallic. Bit by bit, in the case of the interior bodies, we shall have these permanent gases coming back again, and more carbon will be added to their superficial layers; those bodies also must condense before the central one.

If we consider the conditions of the outer condensations, they must be particularly rich in permanent gases. We shall, therefore, get in the case the outer bodies excessively small density, and probably associated with that only the very sparse presence of these metals which have been alone allowed to penetrate toward the center, because their vapors can condense.

Our sun must ultimately go through the stage in which its absorption will be due no longer to hydrogen, or to iron, but to carbon, chiefly by virtue of the process which has been referred to; and eventually, as its radiant energy gets less and less, as it gets cooler and dimmer, the last speck of blood-red sunlight will be put out by an excess of carbon vapors in its atmosphere.

That is what must have happened to our own earth. It is a very interesting question indeed to attempt to determine at what period of the sun's history a solid crust was formed on the planet on which we dwell. It looks very much as if the consolidation of the earth may have preceded the highest point of temperature of the sun—that is to say, that the earth may have reached a condition closely resembling its present one at the time the sun occupied the apex of the temperature curve to which reference has been made.

In any case the high density of the earth, compared with the density of its crust (the enormous quantity of silicon and oxygen and carbon near the crust having an entirely different specific gravity from the specific gravity of the earth taken as a whole), seems to follow as a matter of course from these considerations.

I trust it will be seen that the hypothesis we have been considering supplies us with an orderly progression of meteoritic dust through heat conditions produced by collisions till finally a cool mass is produced; that this orderly progression brings about all the known phenomena of the heavens on its way, and simply and sufficiently explains them. But, though much of the mystery is gone, all the majesty is left—indeed, to my mind it is vastly increased. It seems as if the working out of the meteoritic idea will entirely justify Kant's conviction that the physical side of the science of the universe would in the future reach the same degree of perfection to which Newton had in his time brought the mathematical side.—*Nineteenth Century.*

[NOTE.—In the foregoing remarkable paper the well-known astronomical author and authority, Prof. Lockyer, demonstrates, by a process of observation and reasoning which carries conviction with it at almost every step, the evolution of all the numberless kinds of matter, from the most primary form or substance recognizable by our senses, assisted by the finest and most delicate instrumental adjuncts and physical testings, with which we are acquainted. Of this primary something—appearing as a flocculent mass or nebulosity floating in space—all that we can now say is, that it appears to be hydrogen or some other closely allied substance. Further curdled, or condensed to a degree sufficient to permit its light to be subjected to spectrum analysis, the presence of many of the terrestrial elements—as oxygen, magnesium, iron, carbon, silicon, sulphur, and the like—is revealed to us, apparently associated with the hydrogen in the form of infinitely fine dust; and the evidence and reasoning are to the effect that, from the further and continued condensation and chemical action of this gas and cosmical dust, the condensed nebula, nebulous suns, other suns, planets, and all other forms of associated matter with which we are acquainted, have originated. Like a true scientist, Prof. Lockyer stops here, and does not attempt to go beyond the legitimate scope of scientific observation and deduction. He indeed assumes that this primary matter is endowed with motion, and that the force of gravitation is also present and potential; because it is impossible to conceive of the existence of matter in space free from these qualities. He does not raise the question how the hydrogen, the infinitely fine dust, the qualities of motion and the force of gravitation originated; and the problem of original creation, although removed further back as it were, remains as inscrutable and unanswerable as ever. Nay, more than this, he does not raise the most interesting and startling theme of speculation suggested by this revelation of stellar and matter evolution, which is this: Of this primal form of matter—the beginning of the history of cosmical evolution—one of two things must be true. Either associated with this dust and gas from the beginning were the germs of all the vital and mental energy that have since manifested themselves in connection with matter, or they were not. If the affirmative is true, then vital and mental energy, or what we may term life, was associated with inorganic matter—in an active or latent state—from the beginning. If the negative is the case, then the vital and mental forces or germs have been subsequently introduced or imparted from without. And if so, when and where was the bridge by which matter, life, and spirit were brought into association constructed? There must have been a time and place in cosmical history! A time and place in the process of evolution! If cosmical dust and associated hydrogen, in condensing into nebula and suns, are subjected to heat of a greater degree of intensity than anything within the range of human experience, as all astronomers seem to be agreed, it is certain that nothing organic could have existed concurrently; and there is, therefore, hardly a shadow of evidence that inorganic matter, especially after having been subjected to incandescence, could ever have originated even protoplasm, by mere association of atoms. The evidence would therefore seem to be strongly adverse to the idea of any original association of the vital principle with matter.—Editor.]

SOME LESSONS FROM BARBARISM.

By ELAINE GOODALE.

In the course of several years' conscientious effort to civilize those barbarians within our borders—the American Indians—I have been unwillingly impressed by the fact that barbarism offers several points of evident superiority to our civilization. It is well known that whole tribes of Indians—indeed, all of them to some extent—have been demoralized and degraded by contact with the lowest whites, and are no longer fair types of the barbarian. A few others have been transformed by schools and lands in severalty into commonplace farming communities, with no very striking features of their own. Let us consider briefly the peculiar customs and habits of thought of the wilder tribes of Sioux — a strong, typical aboriginal race — and let us not be afraid or ashamed to admit that barbarism has valuable lessons for civilization.

The first thing about them to attract the attention of a stranger would probably be their dress. The ignorant and narrow-minded sneer at it because it is unlike the one to which they are accustomed —to them it is nothing but "savage finery." The cosmopolitan observer, who recognizes the real superiority of most of the "national costumes" of European and Asiatic countries to that conventional standard—ugly, extravagant, and unhygienic—which seems unhappily destined to supplant them—this man perceives immediately the beauty and propriety of the Indian's dress.

The blanket is convenient, comfortable, and eminently graceful. The fringed buckskin hunting-shirt, leggings, and moccasins have been approved and adopted for more than a century by the intelligent frontiersman, as the best thing possible for the hunter in color, cut, and material. The moccasin especially is acknowledged to be the most perfect foot-covering ever invented. Absolutely comfortable, ornamental, and appropriate, it is worn very commonly by white men, and women too, who have to do with Indians or live near them, and it is the last article of native dress which the "civilized" Indian unwillingly resigns.

The loose, scant robe of the women, with wide flowing sleeves, is almost exactly similar to the well-known Japanese dress, and it is therefore unnecessary to affirm that it is pretty, modest, delightfully comfortable, and ingeniously adapted to the necessities of a primitive existence. I have myself worn it in the wilderness with complete satisfaction, and know by experience how fully it meets the various exigencies of camp life. It requires only five yards of calico, and can be made in two hours! Oh for the ease and freedom, physical, mental, and moral, of a fixed standard of feminine dress which neither deforms, exaggerates, indelicately displays, nor ridiculously cumbers the female form—a dress suitable for all women upon every occasion, and requiring small outlay of time or money or thought! What we all really admire is the healthy, beautiful woman—not the elaborate toilet—and a bit of artistic coloring or graceful lines of drapery are as attainable in a five-cent calico as in a five-dollar brocade.

Another lesson, which many over-civilized people are already learning, is that of outdoor life—life close to Nature. Does not he who "camps out" all summer in the Adirondacks or on the sea-beaches become for the time being a healthy and happy savage? It is scarcely worth while to expatiate upon the sanitary virtues of camp life—as much for the mind as for the body. Every really natural, vigorous, live, thinking person dreads the enervating effects of our artificial indoor existence, in overheated, over-furnished rooms, at luxurious, appetite-destroying tables, and longs for and if possible obtains for himself, during at least a few weeks out of the year, a life mainly on horseback or afoot, at the oar or in the surf; a fine savage hunger, appeased by few and plain dishes; an apotheosis of sleep on a bed of balsam in the tent, or in a hammock under the stars!

So much being granted, it is to be remembered that the Indian can give the white man innumerable "points" on the manner and method of "camping out." Instinctively, or perhaps we should say because of generations of training, he knows the best way to do everything. He is never careless, bungling, or ignorant; but deliberate, systematic, and exact to a degree which is the despair of the uninstructed pale-face. He shrinks neither from danger nor exertion in the pursuit of his ends, yet he never for a moment submits to unnecessary discomfort.

In the Dakota lodge we have the perfection of a canvas house, as was practically admitted when it was made the model for the Sibley army tent, now in such general use. Of course, the original lodge of tanned buffalo-hide was warmer and more durable and more completely water-proof; but even now that this is unattainable, the conical tent of the Dakotas remains the best that has been devised. I have tried them all, and nothing would induce me to use any other. It is more roomy and convenient and a thousand times prettier, because of its circular form, than a "wall-tent," besides being less liable to blow over in a high wind. It is perfectly ventilated as well as warmed by the central fire with its opening above; and the chimney-flaps, which are regulated according to the direction of the wind, carry off all the smoke. It can be turned in a few moments into a cool, shady awning in hot weather, and instantly made almost storm-proof in case of a sudden thunder-shower. The women are adepts at making and breaking camp in the shortest possible time. I have ridden into camp in a cold, drenching rain, at dark; and almost as soon as I had contrived with stiffened limbs to dismount from my pony, remove the saddle and bridle, and picket him out, the *tepee* would be up, beds arranged, a fire made, water fetched, and supper under way—in short, the height of cozy comfort awaiting me.

The men are equally apt at calculating distances, predicting weather, selecting a camping-ground, discovering water in unlikely places, tracking men or animals—in short, in every variety of woodcraft and plainscraft. Both men and women know how to make available a hundred products of nature of which no white man has ever learned the use. They can build a fire in a treeless country, obtain food from the barren wastes in unexpected forms—it may be of a small land-turtle or hidden waterweed—and nearly every leaf or herb, it appears, can be smoked, or steeped, or smelled of, or has some medicinal or edible quality. They are skillful in cooking even such articles of food as they have borrowed from us; and I should never expect, while camping with white people, to taste such admirable hot biscuit as the Indian women will bake on a bed of coals in a common frying-pan, or to see coffee browned and prepared with such dexterity and dispatch.

Indians scrupulously respect the rights of the individual to his personal possessions, and to such privacy as is possible in tent life. Each member of the party has his own bed, seat, and especial corner of the *tepee*, upon which no other ever intrudes, unless compelled by the exigencies of hospitality; and each one keeps his own blankets, clothing, arms, and ornaments in exactly the same place, with reference to the door of the lodge, and observes the same order in packing and repacking throughout the trip. Although the household utensils may be few in number, each has its proper function, and they are much less likely to be promiscuously devoted to various uses than is the disorderly camp equipage of the average white man. Every night the moccasins are neatly mended, and the harness, if any part has given way, repaired in such fashion as to be stronger than before—the little work-bag, containing awls, sinews, and strips of buckskin, is every housewife's companion—and it may be added that bathing is frequently indulged in and garments washed at lake or river side at very short intervals.

Although we have barely touched upon some of the practical lessons to be learned from the savage, we will turn from these to deeper and fundamental questions of social and political organization. Do we really believe that the framework of our modern society is solidly and honestly built? Do we not condemn in almost unqualified terms its false standards, artificial distinctions, and ridiculous elaborations of purely conventional laws? I do not want to be misunderstood as saying that there is nothing artificial or conventional in the social system of our typical barbarian; this would not be strictly true: nevertheless, it is refreshing to dwell among a comparatively simple people—a people whose etiquette is easily learned and based upon an instinctive sense of propriety; who know no prearranged division into classes; whose every-day hospitality is not determined by the desire for or the ability to afford display, but solely by the actual need of the chance guest. It is delightful to hear people come straight to the point, tell home truths, talk frankly and ask frank questions, call a spade a spade, and be as unconscious as a child of any possible motive for doing otherwise. A *naïve* curiosity, a strong sense of humor, a childlike *abandon* to the simple pleasures of the hour, a responsive and receptive quality of mind, and real courtesy of manner, are all characteristic of our barbarian in his hours of social relaxation. He has his faults, but these are always *en evidence:* what we have determined for once frankly to consider is, not what the poor Indian lacks, but in what he actually surpasses us.

I scarcely dare to go deeper, and to compare the modified form of communism and the exceedingly simple mode of government which prevails among these Indians with our political system, so heartily abused and so earnestly defended. It has occurred to me, nevertheless, that the college-bred Indian, the product of our nineteenth-century forcing process for savages, might study with no little wonder and dismay the modern writers on dress-reform, and the enthusiastic advocates of an outdoor life; that he might find his brain begin to whirl as he rose upon the topmost wave of progress, and discovered in Henry George, in Edward Bellamy, in Tolstoi, that the prophets of the new era were trying to make the world unlearn all that it had so recently taught him, and that their red-hot schemes of reformation bore many of the familiar features of that effete "barbarism" which he had so painfully discarded.

Is it barely possible, after all, that the fundamental equality of man, the necessity of equalizing burdens and benefits, the grace to "judge not" and to "give to him that asketh," in the Tolstoian sense, are some of the lessons to be learned from barbarism?

THE USE OF ALCOHOL IN MEDICINE.*

By A. G. BARTLEY, M.D., M.R.C.S.

MY opinion is adverse to the use of alcohol, and I might proceed to give grounds for this opinion; statistics, quotations from authorities, as well as facts, I might supply myself, so as to make my paper more or less exhaustive. My aim is, however, less ambitious. I have called my paper a contribution merely. It is, in short, an account of certain incidents in my experience which bear upon the question; and these I relate as briefly as possible and in the order of their occurrence. I will begin by relating an incident which first directed my attention to this subject, and which will show that I had taken up a strong ground in this controversy even before I was aware there was such a controversy at all.

* A paper entitled "A Contribution toward the Discussion of the Employment of Alcohol in Medicine," read before the Æsculapian Medical Society. Reprinted from the London Lancet.

After I took my degree in medicine I passed at once into the army, and my first cases of independent medical practice were in a battery of artillery in the Punjab. After a year or so with this corps I served two years in an infantry regiment without a senior surgeon, all this time acting to the best of my lights, but entirely independent and uncontrolled. At the end of this period, and about my fifth year of service, a senior surgeon joined the regiment with power of superintendence. He was an able and a kind man, and it was not at all in a spirit of unfriendliness that, going into dinner one night, he said to me, "I was in your ward this afternoon and found a bad case of delirium tremens in which you had omitted to order stimulants; however, I have made it all right." I replied, "I have no case of delirium tremens at present." He said, "Yes, a bad case, which will probably not survive, and so you had better take care." After some consideration I at length made out the case he referred to, and replied, "That man has no delirium tremens and will certainly be at duty in a week." We thus had a difference of opinion. I begged him, however, to leave the case in my hands, which he did, and the man was at duty in fair health in a week. It was, in fact, a discovery to him, an old soldier, that delirium tremens could be treated successfully without stimulants; and, I must add, it was a discovery to me that, although I knew there was such a disease in the regiment, I had actually treated cases of the ailment myself without knowing it. That delirium tremens can be, and ought to be, treated without stimulants is now a commonplace of practice. I speak of the year 1866. At that time the treatment consisted chiefly in administration of stimulants and opium, and I take no great credit to myself for breaking away from the traditions of the profession. I simply did not treat the disease by name. It would now be called "alcoholic poisoning." I looked on recovery as a matter of course, recorded the case as debility, sometimes from drunkenness, but more generally omitted the remark as likely to draw down the attention of the commanding officer to the offender. On the occurrence of the above incident, however, my attention was directed to the subject. I continued my treatment. My two colleagues continued theirs, and, although we were seldom without a case of delirium tremens, no case of any severity occurred among my patients. I need not say that the matter was often warmly debated. In those days Aitken's Practice of Physic was, as it still is, the chief authority in the medical service, and it was with keen delight that in the new edition of that year I found the treatment of this disease laid down: that, as it proceeded from an irritation of the nervous system by alcohol, the first condition of cure was to remove the cause, to forbid alcohol, and to give food in all possible ways, as the patients were dying of starvation—in fact, the treatment I had been pursuing. Aided by this book, I had the pleasure of making a convert of my senior.

The next three years are barren of incident. I served in the Channel Islands the greater part of the time with a battery about one hundred strong, and quite isolated. After this I returned to India, and was put in medical charge of the Artillery Division at Mooltan. It was in this station that I studied the heat fever, in which I was led to adopt a modification of treatment, which included, I may add, an avoidance of alcohol. I early made observation of another troublesome and prevalent Indian ailment—diarrhœa. Patients admitted to hospital with diarrhœa very rapidly recovered by dietetic means alone, and without drugs. The climate of the Punjab is dry, very different from that of Bengal, where, we know, diarrhœa does not always tend to cure itself. In truth, the diarrhœa was curative, proceeding from some improper ingesta, very frequently a symptom of alcoholic poisoning. On coming to hospital, milk and arrowroot were given as diet, and, with rest and quiet, in a day or two the man was well. Similarly among the children diarrhœa, which was in any case rare, proceeded from something unwholesome they had eaten, or from fever. That arising from the former cause cured itself, and fevers in the hospital, cooled artificially, quiet, and darkened, seldom lasted over the second day. So that a child brought to hospital almost insensible with vomiting and diarrhœa would be quite lively next day, and without any special treatment other than cold applications. Thus, in addition to delirium tremens, which was very rare, two other important Indian diseases, diarrhœa and heat fever, were treated by sanitary measures, any drugs employed being mere adjuncts, and alcohol would only have marred the cure.

There were many cases of acute chest disease in the cold weather. On admission to hospital, they had plainly one thing in common with those suffering from alcohol: they were exhausted from sheer want of food. It was the first and main point of my treatment that this should be met by prompt feeding, most generally by repeated cupfuls of arrowroot and milk. I gave niter or other neutral alkaline salt, and morphine for hacking cough. The tongue began to clean at once and the temperature to fall, and the haggard and worn patient got refreshing sleep and began to convalesce. In fact, the cases ran parallel with the former ailments I have mentioned, and I soon ceased to employ with them any form of alcohol. They usually passed through a crisis, sometimes extremely severe. The temperature became subnormal—at least, as evidenced by the thermometer; the face shrunken, with feeble pulse. My practice was, at first, to give hot wine and water in this stage. However, I found that the stage was very transitory, and that hot milk and water was quite as restorative; the patient soon went to sleep, and normal warmth returned.

Hepatic disease is not so frequent in the Punjab as it is found down country, nor by any means so severe. I can not recollect any deaths due to it directly during my stay, or any case of hepatic abscess. Minor congestions and enlargements were a frequent cause of sickness and invaliding. The treatment a few years earlier consisted in blistering, stimulants, and a mercurial course. Some time in 1863 a surgeon in Burmah, whose name I can not now recall, recommended ammonium chloride. This I tried, and thought it acted very favorably. About 1866 an immense change for the better was brought about by the introduction of podophyllin. It was called the vegetable mercury, having quite supplanted that metal, which indeed became on all hands, in all diseases, quite decried. At the time I now refer to (1870) I began to discontinue the use of podophyllin in hepatic disease, finding Epsom salts far more active and rapid in effects. I remember getting the idea from a translation in the Sydenham Society series of some German researches on the effect of certain saline springs, and made for myself an artificial mineral water. This, the equivalent of the present white mixture, eased the pain and reduced the size of the liver, a fact we are now familiar with, but which was then to me a real discovery. After a few days of this treatment the patients were very much the same as convalescents from chest disease. They needed time and rest and suitable food—in short, nursing—and had a chance of regaining health. Hepatic disease is, however, ineradicable. It soon recurs in the great heat of the climate and in men not very abstemious, and few once ailing with it serve long in hot climates.

Thus, in one after the other of these important diseases, experience was altogether against the employment of alcohol. It must be borne in mind that I began with no theory. I gave alcohol in pneumonia and hepatitis, while rigidly withholding it in fever and diarrhœa. I delayed the alcohol, however, in those diseases to a later stage, until the temperature was nearly normal, and at length discontinued it altogether, finding that it retarded the cure and prolonged convalescence. I lost some cases, of course, and, among others, one from delirium tremens—an old soldier, who had frequently suffered before—and it was at first a matter of great pain to me to think that, if I had followed the usual routine of treatment, the cases might have ended differently. My colleagues, I knew, would probably have held so. However, my confidence revived in watching their practice. I had not the mortality or the severity of forms of disease in the hospitals around me. I have seen two waiting men attending on delirious cases, holding the patients in their beds, and preventing their injuring themselves, just as I have seen in the old regiment typical cases of delirium tremens; but I had no such cases, and I had no doubt then, nor have I now, that the delirium arose from the free use of stimulants combined with want of food.

After the regimental system had been abolished I found myself superseded in charge of the corps of artillery with which I had served four years, and was attached to a regiment of infantry. The surgeon-major in charge went on leave soon after I joined, and as I was the next senior, according to the new regulations I assumed charge, although quite a new comer. It was then for the first time I became aware how much I had diverged from the ordinary practice—at least as it was then in the service. The surgeon of the regiment next in rank to myself soon after I joined consulted me about a bad case of hepatitis, with high fever, foul tongue, and diarrhœa. He had given a variety of drugs, which I do not remember. I found, however, that he was giving large quantities of food: jugged hare, strong soups, and six or eight ounces of port wine daily. I said I thought the man was getting too much food to digest, recommended milk diet, to stop the wine, and give salines. He replied, to my astonishment, in a nervous way, he would ask —— his opinion. Now this man he mentioned was only a short time in the country. He was ten years my junior, and six or seven years his junior. I said no more, and went about my business. A few days afterward, however, the matter cropped up again, and he spoke with an astonishing degree of bitterness on the subject. He said he had once before met a man with these views, and he proceeded to refer to a case of mine which he had visited for me on the previous day as likely to die of hectic from want of support. I pointed out to him reasons why the ailment was not hectic, and assured him the man was not in danger. In truth, my case was severe Peshawur fever which resisted quinine, and the diagnosis was doubtful, as the man had originally come to hospital for treatment of a stricture. And, I may add, the man did not die. I saw him often years afterward at Woolwich. I was greatly surprised at the degree of irritation this surgeon displayed, and became aware that the administration or withholding of alcohol was not merely a scientific question, but one for faith and belief, with strong feeling attached thereto. His case of hepatic disease died; so did at least one other in the two months I had charge of the regiment. My colleague did not again seek my advice in his difficulties, and he was clearly not converted, for, I regret to say, he died himself from the disease in the following hot weather.

A few months after my transfer to this regiment I came home in a troop-ship, and there again my divergence of treatment left me utterly isolated. I was third in order of seniority on board, and was put in medical charge of the women and children. It was the last troop-ship of the season, and carried only invalids and soldiers' families. Of the latter there were about seventy, with an average of perhaps two children in each. On the day after leaving Bombay a case of measles was found on board. I took the case into hospital, and every precaution to isolate it was adopted—unavailing, however. The sixth day afterward six cases were reported. After another six days thirty more were found infected and put under treatment; and I think that every child on board passed through the disease. The only number I can now recollect is that, after discharging all convalescents, thirty-six cases were sent to Haslar Hospital on arrival at Portsmouth. There must have been from eighty to one hundred cases in all. All these I treated myself in the hospital, restricting myself to this duty at first with the idea of isolation, afterward in order to control the treatment, for which I was personally responsible. I gave no stimulants, and met every case of high temperature promptly by wet towels to the chest and abdomen, and by giving for food very dilute Swiss milk *ad libitum*. This treatment met with deep disapproval on the part of the mothers, who were all strangers to me, and accustomed to very different treatment. Toward the end of the voyage I found the women were not unsupported in their disapproval. They carried their complaints to the various officers commanding detachments, and thus officially to my senior, the surgeon-major in charge. Now this surgeon-major had been unlucky. He had treated only two children on board, one of them his own son. They were both dead, whereas I had lost no cases, and so, although there was a difference of opinion between us, I had not much difficulty in arranging that the treatment should be left entirely in my hands. I will summarize the result. I was the only medical officer on board who gave no alcohol. I treated personally the largest number of cases, and I alone lost no patients. Moreover, of three children who died on board, two, as I have said, were treated by the senior medical officer, and the third by my assistant. I will give particulars of this, as it is a most illustrative case. It was not a case of measles, and was treated by him in the women's quarters, and I first heard of it when he told me the child was dying. I asked him to let me try to save it, which he gladly did. I put it in hospital with my measles cases. I stopped the wine, very much to its mother's disgust, stayed with it almost an hour, feeding it with milk and water, which it took greedily, and left it fully assured it was out of danger. The child lived for a week, and was slowly improving. I gave it no drugs, as it had no symptoms. At the end of this time I told my assistant, whose patient it had nominally remained, to take it again to the quarters, as the hospital had become so crowded. He did so, and, notwithstanding all he had seen of my practice, he put the child at once on brandy, and it died in a few hours. I will make no further comment on these occurrences except to say that perhaps a more crucial experiment could not be devised.

I reached Portsmouth in April, and expected to find the alcohol question a matter of keen debate in England. I need not say I was in this disappointed. I found matters running in the old groove. This is several years ago. We know matters are now righting themselves. To continue. During three years' tour of duty at home I avoided discussion, and, as far as possible, all consultations. I have, however, one instructive instance to bring forward from that period. In the family of a sergeant of the commissariat two well-grown lads, the eldest about ten years old, had caught measles and were very ailing. The mother frequently suggested that the boys should have stimulants, which I refrained from. Now it happened that this sergeant was married without leave, and his wife and family were not recognized. My attendance on them was therefore voluntary; not only so, but her acceptance of my attendance was voluntary, and I found before many days that the children were taking stimulants under the direction of some private practitioner, and I ceased attending. The father, however, was displeased at this, and in a day or two begged of me to call. I did so, and found a great change for the worse, in the eldest especially. To me the cause was patent; besides that, the room smelled strongly of brandy. I did not mention this, but said to the mother, as kindly as I could, that the boy had no more chance of dying than she or I had if she would follow my directions. She was obdurate, however, and I did not call again. In a day or two afterward the father came and told me the boy had died. This is the last instance I will bring forward from my military service.

I may mention a case which occurred since my coming to North London, a case of unusually large pleuritic effusion. In consultation with a physician, a specialist in chest disease, the fluid was evacuated, and the patient made a rapid recovery. This physician some time afterward remarked to me what an excellent case it was—what a remarkably rapid convalescence. I did not emphasize in my reply, as you may suppose, that which it is my duty now to do, that I had carefully omitted the six ounces of port wine daily he had prescribed for my patient. I did once succeed in converting a hospital physician to my views—a *rara avis in terris*. I one day undertook to stand in the middle of his largest ward, and from that position to point out every patient therein who had been taking stimulants for three or four days at least, and I succeeded. To me the pale worn aspect of the patient is unmistakable.

With this I end my paper. It is not for me to go into statistics on the point, such as may be found, I dare say, in books or hospital reports. I know that such statistics are scant, for the question has not yet become a matter of calm scientific investigation. It is still one of the "fads" of the day, which the practical physician has not time to trouble about. Nevertheless, the reform is irresistibly advancing. No one can overlook the unmistakable diminution of the consumption of alcoholic liquors in hospitals. This is probably due in great measure to the greater temperance of the general community—a change of fashion rather than a reform of practice. It has been said long ago that the evils wrought by a theory have never in history discredited the theory; and certainly this would seem to be true in the practice of medicine. The melancholy history of the use of calomel and of opium in India is a saddening illustration. A few men here and there question the theory, and gain adherents chiefly among the young. The older men are not so much converted. They die out, and by and by the world awakes and exclaims how foolish the last generation was.

HUMAN SELECTION.

By ALFRED RUSSEL WALLACE.

IN one of my latest conversations with Darwin he expressed himself very gloomily on the future of humanity, on the ground that in our modern civilization natural selection had no play, and the fittest did not survive. Those who succeed in the race for wealth are by no means the best or the most intelligent, and it is notorious that our population is more largely renewed in each generation from the lower than from the middle and upper classes. As a recent American writer well puts it, "We behold the melancholy spectacle of the renewal of the great mass of society from the lowest classes, the highest classes to a great extent either not marrying or not having children. The floating population is always the scum, and yet the stream of life is largely renewed from this source. Such a state of affairs, sufficiently dangerous in any society, is simply suicidal in the democratic civilization of our day." *

That the check to progress here indicated is a real one few will

* Hiram M. Stanley, in the Arena for June, 1890.

deny, and the problem is evidently felt to be one of vital importance, since it has attracted the attention of some of our most thoughtful writers, and has quite recently furnished the theme for a perfect flood of articles in our best periodicals. I propose here to consider very briefly the various suggestions made by these writers; and afterward shall endeavor to show that when the course of social evolution shall have led to a more rational organization of society, the problem will receive its final solution by the action of physiological and social agencies, and in perfect harmony with the highest interests of humanity.

Before discussing the question itself, it will be well to consider whether there are in fact any other agencies than some form of selection to be relied on. It has been generally accepted hitherto that such beneficial influences as education, hygiene, and social refinement had a cumulative action, and would of themselves lead to a steady improvement of all civilized races. This view rested on the belief that whatever improvement was effected in individuals was transmitted to their progeny, and that it would be thus possible to effect a continuous advance in physical, moral, and intellectual qualities without any selection of the better or elimination of the inferior types. But of late years grave doubts have been thrown on this view, owing chiefly to the researches of Galton and Weismann as to the fundamental causes to which heredity is due. The balance of opinion among physiologists now seems to be against the heredity of any qualities acquired by the individual after birth, in which case the question we are discussing will be much simplified, since we shall be limited to some form of selection as the only possible means of improving the race.

In order to make the difference between the two theories clear to those who may not have followed the recent discussions on the subject an illustration may be useful. Let us suppose two persons, each striving to produce two distinct types of horse—the cart-horse and the racer—from the wild prairie horses of America, and that one of them believes in the influence of food and training, the other in selection. Each has a lot of a hundred horses to begin with, as nearly as possible alike in quality. The one who trusts to selection at once divides his horses into two lots, the one stronger and heavier, the other lighter and more active, and, breeding from these, continually selects, for the parents of the succeeding generation, those which most nearly approach the two types required. In this way it is perfectly certain that in a comparatively short period—thirty or forty years perhaps—he would be able to produce two very distinct forms, the one a very fair race-horse, the other an equally good specimen of a cart-horse; and he could do this without subjecting the two strains to any difference of food or training, since it *is* by selection alone that our various breeds of domestic animals have in most cases been produced.

On the other hand, the person who undertook to produce similar results by food and training alone, without allowing selection to have any part in the process, would have to act in a very different manner. He would first divide his horses into two lots as nearly as possible identical in all points, and thereafter subject the one lot to daily exercise in drawing loads at a slow pace, the other lot to equally constant exercise in running, and he might also supply them with different kinds of food if he thought it calculated to aid in producing the required effect. In each successive generation he must make no selection of the swiftest or the strongest, but must either keep the whole progeny of each lot, or carefully choose an average sample of each to be again subjected to the same discipline. It is quite certain that the very different kinds of exercise would have some effect on the individuals so trained, enlarging and strengthening a different set of muscles in each, and if this effect were transmitted to the offspring, then there ought to be in this case also a steady advance toward the racer and the cart-horse type. Such an experiment, however, has never been tried, and we can not therefore say positively what would be the result; but those who accept the theory of the non-heredity of acquired characters would predict with confidence that after thirty or forty generations of training without selection, the last two lots of colts would have made little or no advance toward the two types required, but would be practically indistinguishable.

It is exceedingly difficult to find any actual cases to illustrate this point, since either natural or artificial selection has almost always been present. The apparent effects of disuse in causing the diminution of certain organs, such as the reduced wings of some birds in oceanic islands and the very small or aborted eyes of some of the animals inhabiting extensive caverns, can be as well explained by the withdrawal of the cumulative agency of natural selection and by economy of growth, as by the direct effects of disuse. The following facts, however, seem to show that special skill derived from practice, when continued for several generations, is not inherited, and does not therefore tend to increase. The wonderful skill of most of the North American Indians in following a trail by indications quite imperceptible to the ordinary European has been dwelt upon by many writers, but it is now admitted that the white trappers equal and often excel them, though these trappers have in almost every case acquired their skill in a comparatively short period, without any of the inherited experience which might belong to the Indian.

Again, for many generations a considerable portion of the male population of Switzerland have practiced rifle-shooting as a national sport, yet in international contests they show no marked superiority over our riflemen, who are, in a large proportion, the sons of men who never handled a gun. Another case is afforded by the upper classes of this country, who for many generations have been educated at the universities, and have had their classical and mathematical abilities developed to the fullest extent by rivalry for honors. Yet now, that for some years these institutions have been opened to dissenters whose parents usually for many generations have had no such training, it is found that these dissenters carry off their full share or even more than their share of honors. We thus see that the theory of the non-heredity of acquired characters, whether physical or mental, is supported by a considerable number of facts, while few if any are directly opposed to it. We therefore propose to neglect the influence of education and habit as possible factors in the improvement of our race, and to confine our argument entirely to the possibility of improvement by some form of selection.*

Among the modern writers who have dealt with this question the opinions of Mr. Galton are entitled to be first considered, because he has studied the whole subject of human faculty in the most thorough manner, and has perhaps thrown more light upon it than any other writer. The method of selection by which he has suggested that our race may be improved is to be brought into action by means of a system of marks for family merit, both as to health, intellect, and morals, those individuals who stand high in these respects being encouraged to marry early by state endowments sufficient to enable the young couples to make a start in life. Of all the proposals that have been made tending to the systematic improvement of our race, this is one of the least objectionable, but it is also, I fear, among the least effective. Its tendency would undoubtedly be to increase the number and to raise the standard of our highest and best men, but it would at the same time leave the bulk of the population unaffected, and would but slightly diminish the rate at which the lower types tend to supplant or to take the place of the higher. What we want is, not a higher standard of perfection in the few, but a higher average, and this can best be produced by the elimination of the lowest of all and a free intermingling of the rest.

Something of this kind is proposed by Mr. Hiram M. Stanley in his article on Our Civilization and the Marriage Problem, already referred to. This writer believes that civilizations perish

* Those who desire more information on this subject should read Weismann's Essays on Heredity.

because, as wealth and art increase, corruption creeps in, and the new generations fail in the work of progress because the renewal of individuals is left chiefly to the unfit. The two great factors which secure perfection in each animal race—sexual selection by which the fit are born, and natural selection by which the fittest survive—both fail in the case of mankind, among whom are hosts of individuals which in any other class of beings would never have been born, or, if born, would never survive. He argues that, unless some effective measures are soon adopted and strictly enforced, our case will be irremediable; and, since natural selection fails so largely, recourse must be had to artificial selection. "The drunkard, the criminal, the diseased, the morally weak should never come into society. Not reform but prevention should be the cry." The method by which this is proposed to be done is hinted at in the following passages: "In the true golden age, which lies not behind but before us, the privilege of parentage will be esteemed an honor for the comparatively few, and no child will be born who is not only sound in body and mind, but also above the average as to natural ability and moral force"; and again, "The most important matter in society, the inherent quality of the members which compose it, should be regulated by trained specialists."

Of this proposal and all of the same character we may say, that nothing can possibly be more objectionable, even if we admit that they might be effectual in securing the object aimed at. But even this is more than doubtful; and it is quite certain that any such interference with personal freedom in matters so deeply affecting individual happiness will never be adopted by the majority of any nation, or if adopted would never be submitted to by the minority without a life-and-death struggle.

Another popular writer of the greatest ability and originality, who has recently given us his solution of the problem, is Mr. Grant Allen. His suggestion is in some respects the very reverse of the last, yet it is, if possible, even more objectionable. Instead of any interference with personal freedom, he proposes the entire abolition of legal restrictions as to marriage, which is to be a free contract to last only so long as either party desires. This alone, however, would have no effect on race-improvement, except probably a prejudicial one. The essential part of his method is, that girls should be taught, both by direct education and by the influence of public opinion, that the duty of all healthy and intellectual women is to be the mothers of as many and as perfect children as possible. For this purpose they are recommended to choose as temporary husbands the finest, healthiest, and most intellectual men, thus insuring a variety of combinations of parental qualities which would lead to the production of offspring of the highest possible character and to the continual advancement of the race.*

I think I have fairly summarized the essence of Mr. Grant Allen's proposal, which, though enforced with all his literary skill and piquancy of illustration, can, in my opinion, only be fitly described by the term already applied to it by one of his reviewers, "detestable." It purports to be advanced in the interests of the children and of the race; but it would necessarily impair that family life and parental affection which are the prime essentials to the well-being of children; while, though it need not necessarily produce, it would certainly favor, the increase of pure sensualism, the most degrading and most fatal of all the qualities that tend to the deterioration of races and the downfall of nations. One of the modern American advocates of greater liberty of divorce, in the interest of marriage itself, thus admirably summarises the essential characteristics and purport of true marriage: "In a true relation, the chief object is the loving companionship of man and woman, their capacity for mutual help and happiness, and for the development of all that is noblest in each other. The second object is the building up a home and family, a place of rest, peace, security, in which child-life can bud and blossom like flowers in the sunshine." † For such rest, peace, and security, permanence is essential. This permanence need not be attained by rigid law, but by the influence of public opinion, and, more surely still, by those deep-seated feelings and emotions which, under favorable conditions, render the marriage tie stronger and its influence more beneficial the longer it endures. To me it appears that no system of the relations of men and women could be more fatal to the happiness of individuals, the well-being of children, or the advancement of the race, than that proposed by Mr. Grant Allen.

Before proceeding further with the main question it is necessary to point out that, besides the special objections to each of the proposals here noticed, there is a general and fundamental objection. They all attempt to deal at once, and by direct legislative enactment, with the most important and most vital of all human relations, regardless of the fact that our present phase of social development is not only extremely imperfect but vicious and rotten at the core. How can it be possible to determine and settle the relations of women to men which shall be best alike for individuals and for the race, in a society in which a very large proportion of women are obliged to work long hours daily for the

* See The Girl of the Future, in The Universal Review, May, 1890, and a previous article entitled Plain Words on the Woman Question, in the Fortnightly Review, October, 1889.

† Elizabeth Cady Stanton in the Arena, April, 1890.

barest subsistence, while another large proportion are forced into more or less uncongenial marriages as the only means of securing some amount of personal independence or physical well-being? Let any one consider, on the one hand, the lives of the wealthy as portrayed in the society newspapers and even in the advertisements of such papers as The Field and The Queen, with their endless round of pleasure and luxury, their almost inconceivable wastefulness and extravagance, indicated by the cost of female dress and such facts as the expenditure of a thousand pounds on the flowers for a single entertainment; and, on the other hand, the terrible condition of millions of workers—men, women, and children—as detailed in the Report of the Lords Commission on Sweating, on absolutely incontestable evidence, and the still more awful condition of those who seek work of any kind in vain, and, seeing their children slowly dying of starvation, are driven in utter helplessness and despair to murder and suicide. Can any thoughtful person admit for a moment that, in a society so constituted that these overwhelming contrasts of luxury and privation are looked upon as necessities, and are treated by the Legislature as matters with which it has practically nothing to do, there is the smallest probability that we can deal successfully with such tremendous social problems as those which involve the marriage tie and the family relation as a means of promoting the physical and moral advancement of the race? What a mockery to still further whiten the sepulchre of modern society, in which is hidden "all manner of corruption," with schemes for the moral and physical advancement of the race!

It is my firm conviction, for reasons which I shall state presently, that when we have cleansed the Augean stable of our existing social organization, and have made such arrangements that *all* shall contribute their share of either physical or mental labor, and that all workers shall reap the *full* reward of their work, the future of the race will be insured by those laws of human development that have led to the slow but continuous advance in the higher qualities of human nature. When men and women are alike free to follow their best impulses; when idleness and vicious or useless luxury on the one hand, oppressive labor and starvation on the other, are alike unknown; when all receive the best and most thorough education that the state of civilization and knowledge at the time will admit; when the standard of public opinion is set by the wisest and the best, and that standard is systematically inculcated on the young; then we shall find that a system of selection will come spontaneously into action which will steadily tend to eliminate the lower and more degraded types of man, and thus continuously raise the average standard of the race. I therefore strongly protest against any attempt to deal with this great question by legal enactments, or by endeavoring to modify public opinion as to the beneficial character of monogamy and permanence in marriage. That the existing popular opinion is the true one is well and briefly shown by Miss Chapman in a recent number of Lippincott's Magazine; and as her statement of the case expresses my own views, and will, I think, be approved by most thinkers on the subject, I here give it:

1. *Nature* plainly indicates permanent marriage as the true human relation. The young of the human pair need parental care and supervision for a great number of years.

2. *Instinct* is strongly on the side of indissoluble marriage. In proportion as men leave brutedom behind and enter into the fullness of their human heritage, they will cease to tolerate the idea of two or more living partners.

3. *History* shows conclusively that where divorce has been easy, licentiousness, disorder, and often complete anarchy have prevailed. The history of civilization is the history of advance in monogamy, of the fidelity of one man to one woman, and one woman to one man.

4. *Science* tells the same tale. Physiology and hygiene point to temperance, not riot. Sociology shows how man, in spite of himself, is ever striving, through lower forms, upward, to the monogamic relation.

5. *Experience* demonstrates to every one of us, individually, the superiority of the indissoluble marriage. We know that, speaking broadly, marriages turn out well or ill in proportion as husband and wife are—let me not say loving—but loyal, sinking differences and even grievances for the sake of children and for the sake of example.

We have now to consider what would be the probable effect of a condition of social advancement, the essential characteristics of which have been already hinted at, on the two great problems—the increase of population, and the continuous improvement of the race by some form of selection which we have reason to believe is the only method available. In order to make this clear, however, and in order that we may fully realize the forces that would come into play in a just and rational state of society, such as may certainly be realized in the not distant future, it will be necessary to have a clear conception of its main characteristics. For this purpose, and without committing myself in any way to an approval of all the details of his scheme, I shall make use of Mr. Bellamy's clear and forcible picture of the society of the future, as he supposes it may exist in America in little more than a century hence.*

The essential principle on which society is supposed to be founded is that of a great family. As in a well-regulated modern family, the elders, those who have experience of the labors, the duties, and the responsibilities of life, determine the general mode of living and working, with the fullest consideration for the con-

* Looking Backward. See especially chapters vii, ix, xii, and xxv.

venience and real well-being of the younger members, and with a recognition of their essential independence. As in a family, the same comforts and enjoyments are secured to all, and the very idea of making any difference in this respect to those who from mental or physical disability are unable to do so much as others, never occurs to any one, since it is opposed to the essential principles on which a true society is held to rest. As regards education all have the same advantages, and all receive the fullest and best training, both intellectual and physical; every one is encouraged to follow out those studies or pursuits for which they are best fitted, or for which they exhibit the strongest inclination. This education, the complete and thorough training for a life of usefulness and enjoyment, continues in both sexes till the age of twenty-one (or thereabouts), when all alike, men and women, take their place in the ranks of the industrial army in which they serve for three years. During the latter years of their education, and during the succeeding three years of industrial service, every opportunity is given them to see and understand every kind of work that is carried on by the community, so that at the end of the term of probation they can choose what department of the public service they prefer to enter. As every one—men, women, and children alike—receive the same amount of public credit—their equal share of the products of the labor of the community, the attractiveness of various pursuits is equalized by differences in the hours of labor, in holidays, or in special privileges attached to the more disagreeable kinds of necessary work, and these are so modified from time to time that the volunteers for every occupation are always about equal to its requirements. The only other essential feature that it is necessary to notice for our present purpose is the system of grades, by which good conduct, industry, and intelligence in every department of industry and occupation are fully recognized, and lead to appointments as overseers, superintendents, or general managers, and ultimately to the highest offices of the state. Every one of these grades and appointments is made public; and as they constitute the only honors and the only differences of rank, with corresponding insignia and privileges, in an otherwise equal body of citizens, they are highly esteemed, and serve as ample inducements to industry and zeal in the public service.

At first sight it may appear that in any state of society whose essential features were at all like those here briefly outlined, all the usual restraints to early marriage as they now exist would be removed, and that a rate of increase of the population unexampled in any previous era would be the result, leading in a few generations to a difficulty in obtaining subsistence, which Malthus has shown to be the inevitable result of the normal rate of increase of mankind when all the positive as well as the preventive checks are removed. As the positive checks—which may be briefly summarized as war, pestilence, and famine—are supposed to be non-existent, what, it may be asked, are the preventive checks which are suggested as being capable of reducing the rate of increase within manageable limits? This very reasonable question I will now endeavor to answer.

The first and most important of the checks upon a too rapid increase of population will be the comparatively late average period of marriage, which will be the natural result of the very conditions of society, and will besides be inculcated during the period of education, and still further enforced by public opinion. As the period of systematic education is supposed to extend to the age of twenty-one, up to which time both the mental and physical powers will be trained and exercised to their fullest capacity, the idea of marriage during this period will rarely be entertained. During the last year of education, however, the subject of marriage will be dwelt upon, in its bearing on individual happiness and on social well-being, in relation to the welfare of the next generation and to the continuous development of the race. The most careful and deliberate choice of partners for life will be inculcated as the highest social duty; while the young women will be so trained as to look with scorn and loathing on all men who in any way willfully fail in their duty to society—on idlers and malingerers, on drunkards and liars, on the selfish, the cruel, or the vicious. They will be taught that the happiness of their whole lives will depend on the care and deliberation with which they choose their husbands, and they will be urged to accept no suitor till he has proved himself to be worthy of respect by the place he holds and the character he bears among his fellow-laborers in the public service.

Under social conditions which render every woman absolutely independent, so far as the necessaries and comforts of existence are concerned, surrounded by the charms of family life and the pleasures of society, which will be far greater than anything we now realize when all possess the refinements derived from the best possible education, and all are relieved from sordid cares and the struggle for mere existence, is it not in the highest degree probable that marriage will rarely take place till the woman has had three or four years' experience of the world after leaving college—that is, till the age of twenty-five, while it will very frequently be delayed till thirty or upward? Now Mr. Galton has shown, from the best statistics available, that if we compare women married at twenty with those married at twenty-nine, the proportionate fertility is about as eight to five. But this difference, large as it is, only represents a portion of the effect on the rate of increase of population caused by a delay in the average period of marriage. For when the age of marriage is delayed the time between successive generations is correspondingly lengthened; while a still further effect is produced by the fact that the greater the average age of marriage the fewer generations are alive at the same time, and it is the combined effect of these three factors that determines the actual rate of increase of the population.*

But there is yet another factor tending to check the increase of population that would come into play in a society such as we have been considering. In a remarkable essay on the Theory of Population, Herbert Spencer has shown, by an elaborate discussion of the phenomena presented by the whole animal kingdom, that the maintenance of the individual and the propagation of the race vary inversely, those species and groups which have the shortest and most uncertain lives producing the greatest number of offspring; in other words, individuation and reproduction are antagonistic. But individuation depends almost entirely on the development and specialization of the nervous system, through which, not only are the several activities and co-ordinations of the various organs carried on, but all advance in instinct, emotion, and intellect is rendered possible. The actual rate of increase in man has been determined by the necessities of the savage state, in which, as in most animal species, it has usually been only just sufficient to maintain a limited average population. But with civilization the average duration of life increases, and the possible increase of population under favorable conditions becomes very great, because fertility is greater than is needed under the new conditions. The advance in civilization as regards the preservation of life has in recent times become so rapid, and the increased development of the nervous system has been limited to so small a portion of the whole population, that no general diminution in fertility has yet occurred. That the facts do, however, accord with the theory is indicated by the common observation that highly intellectual parents do not as a rule have large families, while the most rapid increase occurs in those classes which are engaged in the simpler kinds of manual labor. But in a state of society in which all have their higher faculties fully cultivated and fully exercised throughout life, a slight general diminution of fertility would at once arise, and this diminution, added to that caused by the later average period of marriage, would at once bring the rate of increase of population within manageable limits. The same general principle enables us to look forward to

* See Inquiries into Human Faculty and its Development, p. 321; and Hereditary Genius, p. 353.

that distant future when the world will be fully peopled, in perfect confidence that an equilibrium between the birth and death rates will then be brought about by a combination of physical and social agencies, and the bugbear of over-population become finally extinct.*

There now only remains for consideration the means by which, in such a society, a continuous improvement of the race could be brought about, on the assumption that for this purpose education is powerless as a direct agency, since its effects are not hereditary, and that some form of selection is an absolute necessity. This improvement I believe will certainly be effected through the agency of female choice in marriage. Let us, therefore, consider how this would probably act.

It will be generally admitted that, although many women now remain unmarried from necessity rather than from choice, there are always a considerable number who feel no strong inclination to marriage, and who accept husbands to secure a subsistence or a home of their own rather than from personal affection or sexual emotion. In a society in which women were all pecuniarily independent, were all fully occupied with public duties and intellectual or social enjoyments, and had nothing to gain by marriage as regards material well-being, we may be sure that the number of the unmarried from choice would largely increase. It would probably come to be considered a degradation for any woman to marry a man she could not both love and esteem, and this feeling would supply ample reasons for either abstaining from marriage altogether or delaying it till a worthy and sympathetic husband was encountered. In man, on the other hand, the passion of love is more general, and usually stronger; and as in such a society as is here postulated there would be no way of gratifying this passion but by marriage, almost every woman would receive offers, and thus a powerful selective agency would rest with the female sex. Under the system of education and of public opinion here suggested there can be no doubt how this selection would be exercised. The idle and the selfish would be almost universally rejected. The diseased or the weak in intellect would also usually remain unmarried; while those who exhibited any tendency to insanity or to hereditary disease, or who possessed any congenital deformity, would in hardly any case find partners, because it would be considered an offense against society to be the means of perpetuating such diseases or imperfections.

We must also take into account a special factor hitherto, I believe, unnoticed in this connection, that would in all probability

* A Theory of Population deduced from the General Law of Animal Fertility. Republished from the Westminster Review for April, 1852.

intensify the selection thus exercised. It is well known that females are largely in excess of males in our existing population, and this fact, if it were a necessary and permanent one, would tend to weaken the selective agency of women, as it undoubtedly does now. But there is good reason to believe that it will not be a permanent feature of our population. The births always give a larger proportion of males than females, varying from three and a half to four per cent. But boys die so much more rapidly than girls that when we include all under the age of five the numbers are nearly equal. For the next five years the mortality is nearly the same in both sexes; then that of females preponderates up to thirty years of age; then up to sixty that of men is the larger, while for the rest of life female mortality is again greatest. The general result is that at the ages of most frequent marriage—from twenty to thirty-five—females are between eight and nine per cent in excess of males. But during the ages from five to thirty-five we find a wonderful excess of male deaths from two preventible causes—"accident" and "violence." For the year 1888 the deaths from these causes in England and Wales were as follows:

Males (5 to 35 years), 4,158.
Females (5 to 35 years), 1,100.*

Here we have an excess of male over female deaths in one year of 3,058, all between the ages of five and thirty-five, a very large portion of which is no doubt due to the greater risks run by men and boys in various industrial occupations. In a state of society in which the bulk of the population were engaged in industrial work it is quite certain that almost all these deaths would be prevented, and thus bring the male population more nearly to an equality with the female. But there are also many unhealthy employments in which men are exclusively engaged, such as the grinders of Sheffield, the white-lead manufacturers, and many others; and many more men have their lives shortened by labor in unventilated workshops, to say nothing of the loss of life in war. When the lives of all its citizens are accounted of equal value to the community, no one will be allowed to suffer from such preventible causes as these; and this will still further reduce the mortality of men as compared with that of women. On the whole, then, it seems highly probable that in the society of the future the superior numbers of males at birth will be maintained throughout life, or, at all events, during what may be termed the marriageable period. This will greatly increase the influence of women in the improvement of the race. Being a minority, they will be more sought after, and will have a real choice in marriage, which is rarely the case now. This actual minority being fur-

* Annual Report of the Registrar General, 1888, pp. 106–7.

ther increased by those who, from the various causes already referred to, abstain from marriage, will cause considerable numbers of men to remain permanently unmarried, and as these will consist very largely, if not almost wholly, of those who are the least perfectly developed either mentally or physically, the constant advance of the race in every good quality will be insured.

This method of improvement by elimination of the worst has many advantages over that of securing the early marriages of the best. In the first place, it is the direct instead of the indirect way, for it is more important and more beneficial to society to improve the average of its members by getting rid of the lowest types than by raising the highest a little higher. Exceptionally great and good men are always produced in sufficient numbers, and have always been so produced in every phase of civilization. We do not need more of these so much as we need less of the weak and the bad. This weeding-out system has been the method of natural selection by which the animal and vegetable worlds have been improved and developed. The survival of the fittest is really the extinction of the unfit. In nature this occurs perpetually on an enormous scale, because, owing to the rapid increase of most organisms, the unfit which are yearly destroyed form a large proportion of those that are born. Under our hitherto imperfect civilization this wholesome process has been checked as regards mankind; but the check has been the result of the development of the higher attributes of our nature. Humanity—the essentially *human* emotion—has caused us to save the lives of the weak and suffering, of the maimed or imperfect in mind or body. This has to some extent been antagonistic to physical and even intellectual race-improvement; but it has improved us morally by the continuous development of the characteristic and crowning grace of our human, as distinguished from our animal, nature.

In the society of the future this defect will be remedied, not by any diminution of our humanity, but by encouraging the activity of a still higher human characteristic—admiration of all that is beautiful and kindly and self-sacrificing, repugnance to all that is selfish, base, or cruel. When we allow ourselves to be guided by reason, justice, and public spirit in our dealings with our fellow-men, and determine to abolish poverty by recognizing the equal rights of all the citizens of our common land to an equal share of the wealth which all combine to produce—when we have thus solved the lesser problem of a rational social organization adapted to secure the equal well-being of all, then we may safely leave the far greater and deeper problem of the improvement of the race to the cultivated minds and pure instincts of the Women of the Future.—*Fortnightly Review.*

SCHOOL LIFE IN RELATION TO GROWTH AND HEALTH.*

By Prof. AXEL KEY (of Stockholm).

ONE of our highest, and at the same time one of the pleasantest, objects in life is the instruction of our children. It is our duty to promote their physical and mental health by all the means in our power; and the success of our efforts to that end is one of our greatest joys. The doubt has gradually grown strong whether modern instruction at home and in school, as a whole, is so arranged and guided that the aim of a sound mind in a sound body, which should never be left out of sight, is reached. More and more sharply is the question of the influence of the present school system on the growing youth debated in every enlightened country of Europe. More and more distinctly is it declared, especially from the side of the doctors, that the school imposes too great demands upon the young organism in the critical period of its growth; that it, as well as all our education, seeks too one-sidedly to stimulate mental growth, and that the physical development is thereby so neglected that great dangers arise, perhaps fatal for the whole life, to the body as well as to the closely related mental health. Much as has been thought and written on the subject, and much as school hygiene has been advanced recently, thorough investigations of the condition of children's health in schools have not hitherto been made in other countries than Denmark and Sweden, and a practical basis for conclusions on the matter is therefore wanting. The first fundamental research was instituted by Dr. Hertel in Copenhagen in 1881, and its result was so significant that a special hygienic commission was appointed to examine the conditions of health in all the schools of the kingdom. At the same time a grand school commission was named by the Government of Sweden to inquire into the organization of the whole higher school life. This commission, of which I am a member, has examined nearly fifteen thousand boys from the middle schools or the preparatory schools for the university, and three thousand girls in the private girls' schools, in reference to their health, and has measured and weighed them. The results of these researches show that boys pass through three distinct periods of growth: a moderate increase in their seventh and eighth years; a weaker growth from their ninth to their thirteenth years, and a much more rapid increase in height and weight from their fourteenth to their sixteenth years, or during the period of puberty.

* Address before the International Medical Congress in Berlin. Translated for the Popular Science Monthly from the Internationale klinische Rundschau.

The growth continues after the last period, but more slowly. The development of girls also presents distinct periods, but the changes occur a few years earlier than in boys. It may be mentioned for comparison that American boys are taller and heavier than Swedish boys during the period of puberty, but that otherwise the Swedes excel all other boys and pass the Americans in their nineteenth year. Danish boys compare well with Swedish, and Hamburg boys, according to Kotelmann's researches, come very near to them. The smallest boys examined were those in Belgium and northern Italy. Swedish girls are decidedly taller and have greater weight than the girls examined in other countries. Comparing the subjects by stations in life, the more rapid growth begins a year earlier in the children of the well-to-do classes than in those of the poorer classes. Scanty and hard conditions of life are restrictive and hindering to the growth of children. The slow growth of the poorer children previous to the period of puberty is prolonged at the cost of the latter; it is as if something hindered these children from entering their period of more rapid development in the same year of their life as children living in better circumstances. The development of puberty is delayed in them, but as soon as it is begun it goes on with increased rapidity, and, in spite of the delay, is completed in the same year as it is in the better situated children. We see here a striking example of the elasticity that resides in children and asserts itself in the processes of growth. A feather can be bent very forcibly or nearly doubled up, without losing the power of springing back to its former condition. But if the pressure is too strong or lasts too long, the power is lost—the quill gives way or acquires a permanent set. So a child which has been held back in its growth by unfavorable circumstances has a marvelous power of winning back what it has lost, and of returning in growth to its development-curve. But if the disturbing influences take too sharp a hold or persist too long, the child continues so far backward in its development that it is never able to make it normal again.

It is an interesting question, and especially important in relation to education, whether the growth of children goes on evenly during the different seasons, in summer and winter. Some penetrating researches in this matter have been made by Pastor Malling-Hansen, superintendent of an institute for the deaf and dumb in Copenhagen. According to them, children exhibit a relatively light growth from the end of November to the end of March. This period, which includes all the winter months, is followed by a second, from the end of March till July or August, during which the children grow rapidly in height, but their increase in weight is reduced to a minimum. After this follows a third period, continuing to the end of November, in which the increase in height is very small and the gain in weight very large. The daily accession of weight is often three times as great as during the winter months; and an earlier beginning of the summer vacation will be accompanied by a stronger growth in weight during the holiday time. These facts are of great moment in aiding to determine the best arrangement of vacations—an important question in school management.

From this discussion of the different phases in their growth I pass to the diseases of our school children. First, according to my examinations of fifteen thousand boys in the middle schools, more than one third are ill or are afflicted with chronic maladies. Short-sightedness, which is demonstrably for the most part induced by the overtaxing of the eyes in school-work, and well merits the name of school-sickness, rises rapidly in height of prevalence from class to class. Thirteen and a half per cent of the boys suffer from habitual headache, and nearly thirteen per cent are pallid; and other diseases arise in the lower classes and then decline to rise again in the upper classes. Diseases of the lungs are most frequent among organic disorders. Diseases of the heart and intestinal disorders show a considerable tendency to increase in the higher classes. As to the average of illness in the different classes, it appears that in Stockholm seventeen per cent of the children in the first class were ill at the end of the first school year. In the second school year the illness-curve rose to thirty-seven per cent, and in the fourth class to forty per cent. This remarkable increase of illness during the first school year is not casual, but is exhibited in all the schools; and corresponding conditions were brought to light in the examinations of Danish pupils. A sickness ratio of 34·4 per cent was found as early as in the lowest classes of the middle schools. The illness-curve rose in the first classes, reached its first maximum in the third class, then sunk and rose again in the upper classes. These wavering conditions can not be founded in the organization of the school. The burden of work on the pupil rises incessantly from class to class, and the boys live continuously under the same hygienic conditions in the same places, and in the same school and parental houses. There must be a deeper underlying cause. A look at the growth-periods of the boys shows that the remarkable rise of the sickness-curve in the preparatory schools and the lower classes of the middle schools occurs exactly during the period from seven or eight years to thirteen years, the very time that has been shown to be one of weaker growth in boys. But as soon as the stronger growth of puberty sets in, and especially during the last years of that period, when the gain in weight is most rapid, the curve sinks from class to class, from year to year, till the year in which the important change is completed. Immediately after this point is reached, when the yearly increase in weight and height begins to diminish rapidly, the sickness-curve again rises very fast. The most healthy of all the years of youth is with boys the seventeenth, which is also one of the two years of most active growth. The eighteenth, on the contrary, which follows immediately upon the attainment of puberty, appears to be a very unhealthy year.

All this indicates undoubtedly that during the period of weak growth which precedes the coming on of puberty, and during which our pupils are passing through the preparatory or lowest classes of the middle schools, the power of resistance of the youthful organism against external influences is diminished. During the period of development of puberty, on the other hand, when the youthful life is approaching maturity with all its swelling force, the capacity for resistance rises from year to year, and the liability to illness falls, reaching its minimum in the last year of that period. Immediately afterward sets in another period of diminished capacity for resistance, which usually includes the last years of school life.

Among the school girls, the future mothers of generations to come, investigations instituted in thirty-five schools with three thousand and seventy-two pupils brought out a fearful amount of illness. Sixty-one per cent of the whole, all belonging to the well-to-do classes, were ill or afflicted with serious chronic disorders; thirty-six per cent were suffering from chlorosis, and as many from habitual headache; at least ten per cent had spinal disorder, etc. Such a condition of health in Swedish girls, growing worse in the years preceding puberty and during its beginning, while it is not notably improved in the last years of the period, certainly deserves careful attention. The explanation of it is easily found in the method of instruction for girls as a whole, and in the organization of girls' schools after the pattern of boys' schools. The amount of work, sitting still, etc., exacted of the girl is not consistent with her health during her growing time. Without going into particulars as to the influences injurious to the health of growing children which proceed from their homes or may be brought out in connection with the school and school-work, it is still manifest that the burden of work which children have to bear under present school regulations far exceeds what is permissible, and is to a large extent responsible for the liability of school children to illness.

The average time daily demanded by the school for work in class and at home is, according to the gymnasial schedules, seven hours in the lowest classes; and it rises rapidly and constantly, till in the upper classes eleven or twelve hours are required. As the time here given is the average, and private instruction and optional study hours are not included, it is easy to conceive that there must be a considerable number of boys who have to take more time for school-work.

How do children thus situated find time for meals, for rest, for exercise in the open air, for recreation, and, above all, for sleep? Must not their mental force be worn out and benumbed by such a burden, their physical growth and health suffer, and their capacity to resist unwholesome influences of every kind be diminished? There is no doubt about the answer. The mention of sleep raises a question of great importance to the rational teaching of children. We all know how much greater is the need of children for sleep than of grown persons, and how necessary for their good it is to be able fully to satisfy this need; but how great it is generally at any particular age of the child is very hard to define exactly. The amount varies under different climatic conditions. In Sweden, we consider a sleep of eleven or twelve hours necessary for the younger school children, and of at least eight or nine hours for the older ones. Yet the investigations have shown that this requirement lacks much of being met in all the classes, through the whole school. Boys in the higher classes get but little more than seven hours in bed; and as that is the average, it is easy to perceive that many of them must content themselves with still less sleep. It is also evident from the investigations that the sleeping time is diminished with the increase of the working hours from class to class, so that pupils of the same age enjoy less according as they are higher in their classes. It thus appears constantly that in schools of relatively longer hours of work, the sleeping time of the pupils is correspondingly shorter. In short, the prolongation of the working hours takes place for the most part at the cost of the time for sleep. If, then, the load of work of a school youth is too much for his stage of growth, and too little time is left for recuperation and sleep, the momentous question arises, whether it has been statistically proved that the length of the working time exercises a definite influence on the health of the children. It has. The average time of work of each class was computed, and the pupils were divided into two groups, consisting of those who studied more and those who studied less than the mean. It was found that the amount of illness of those who worked longer than the average was 5·3 per cent higher than that of those who worked less; a result which must be regarded as of very great importance when we consider how many other unhealthy influences there are to make themselves felt. The result was still more significant in the two lowest classes. The liability to illness there, in connection with the longer hours of work, was from 8·6 to seven per cent higher. We may also observe in this condition a new evidence of the depreciation of the capacity of the younger pupils of these classes to resist unhealthy influences.

It is incumbent on us to see with all possible care that the growth of youth during their years of puberty, which is so full of importance, is not disturbed or distorted by any influences adverse to nature. But as instruction is now arranged, at school and at home, we should first of all direct attention to the phase of the child's age immediately preceding the period of puberty, when the growth is at its lowest, the child's capacity for resistance is least, and his liability to illness increases from year to year. We must learn how to obviate this liability to illness, and it is for science to forge the weapons with which to do it.

The deeper we go into these researches, the more we appreciate the great truth that lies in the conception expressed by Rousseau in the last century. When, he thought, we have brought a boy to the age of puberty with a body sound, healthy, and well developed in all respects, then his understanding also will unfold rapidly and attain full maturity under continuous natural direction and instruction; all the more vigorous will his physical development be afterward in the bloom of youth. Rousseau, we know, would not recognize a compulsory lesson in a book before the twelfth year as a means of instruction. We can not follow him so far, but we certainly shall have to learn, better than we know now, how to fit our demands on the child's organization to his strength and capacity of resistance during the different periods of his growth; better than we know now, how to promote his health and his vigorous physical development. The father of school hygiene, Johann Peter Frank, introduced his warning a hundred years ago against a too early and too strong tension of the youthful powers of mind and body with the words: "Yet spare their fibers—spare their mind's strength; waste not upon the child the vigor of the man that is to be."

It is shown by M. Camena d'Almeida, from a comparison of mountain-heights as given in Berghause's table, that the altitude of the highest masses increases in going from the polar to the equatorial regions; yet the greatest elevations are not found at the equator, but near the tropics—in 27° 59′ and 35° 28′ north in Asia, and 15° 52′ and 19° 47′ south in South America. These points are also near the isothermal lines of the highest summer temperatures. The heights of the mountains seem, too, to bear a relation to the height of the line of perpetual snow, they seldom rising more than from six thousand to ten thousand feet above it. From these facts the author deduces a relation between the height of mountains and climate; assuming that there is a limit above the snow-line above which, if a mountain passes it, it is so ground down by frost and the wear of the elements as speedily to be reduced to a proper level.

SKETCH OF AMOS EATON.

PROF. AMOS EATON was one among those who cultivated science in the earlier half of this century, who labored to popularize the study and make it accessible to the masses. American geology and botany owe much to him. His books on those subjects have two special merits—they were among the first published in which a systematic treatment for America was attempted, and they were written throughout in a language that all could read.

AMOS EATON was born in Chatham, Columbia County, N. Y., May 17, 1776, and died in Troy, N. Y., May 6, 1842. His father, Abel Eaton, was a farmer in comfortable circumstances, and of the best standing as a citizen. The scholastic tendencies which determined the character of his career appear to have shown themselves at an early age, for we find that in 1790, when he was only fourteen years old, he was appointed to make a fourth-of-July oration, and acquitted himself acceptably in the effort. Serving as a chain-bearer in the surveying of some land, he acquired a taste for that business. He had no instruments, and, in order to obtain them, he arranged with a blacksmith to "blow and strike" for him by day, in return for which the blacksmith should help him make instruments at night. After several weeks' work, a needle, magnetized from kitchen tongs, and a working chain were turned out. A compass-case was made out of the bottom of an old pewter plate, well smoothed, polished, and graduated; and the young man, at sixteen years of age, was ready to do little jobs of surveying.

He fitted himself for college with the Rev. Dr. David Potter, of Spencertown; entered Williams College, and was graduated thence in 1799, with a high standing in science. He prepared himself for the legal profession, studying law with the Hon. Elisha Williams, of Spencertown, and the Hon. Josiah Ogden, of New York. An association which he formed in New York with Dr. David Hosack and Dr. Samuel L. Mitchill, the most distinguished scientific men in the city at the time, marked another determinative point in his career; for, under their instruction, he became interested in the natural sciences, and particularly in botany. So earnest did he become in these studies that, having borrowed Kirwan's Mineralogy, he made a manuscript copy of the whole work. Having been admitted to the bar of the Supreme Court of New York, he settled in Catskill as a lawyer and land agent, and continued his studies in science. At this place he began, in 1810, a popular course of lectures on botany, which is believed to have been the first attempted in the United States.

In connection with the lectures he compiled a small elementary treatise. Dr. Hosack commended him as being the first in the field with this course, saying: "You have adopted the true system of education, and very properly address yourself to the memory."

Finding that his taste for the incidents of legal practice was diminishing, and his interest in science was growing upon him, Mr. Eaton resolved to abandon the law and devote himself to the more congenial pursuit. He removed to New Haven in 1815, and there placed himself under the tuition of Prof. Silliman, who was lecturing on chemistry, geology, and mineralogy. He enjoyed the advantage of Prof. Silliman's library and of that of Prof. Ives, in which works on botany and materia medica were prominent, and was a diligent student of the college cabinet of minerals. He removed to Williams College, where he gave courses of lectures to volunteer classes of the students on botany, mineralogy, and geology, and awakened a permanent interest in the natural sciences. An interesting description of his personality at this time, when he was in his prime, is given by Prof. Albert Hopkins, who speaks of him as "of striking personage, a large form, somewhat portly and dignified, though entirely free from what is commonly called *starch*. His face was highly intellectual, the forehead high and somewhat retreating, locality strongly marked, and the organs of observation and compassion well developed. His hair was black, and, being combed back, rendered his fine physiognomy still more striking." In the same year the first edition was published of Prof. Eaton's Manual of Botany, a work the appearance of which, according to Dr. Lewis C. Beck, gave an impulse to the study of botany in New England and New York, which had been hampered by the want of a manual in English. The only descriptive work previous to this one was that of Pursch, in which the descriptions were in Latin. The Manual was added to and became fuller, in successive editions, till the eighth edition, published in 1840, was a large octavo volume of 625 pages, known as the North American Botany of Profs. Eaton and Wright, and contained descriptions of 5,267 species of plants.

From Williams College the lectures were extended, in the shape of courses, with practical instructions to classes, to the larger towns of New England and New York. Prof. Eaton was greatly aided in this enterprise by the patronage and encouragement he had received from the faculty and students of Williams College, and the fame he derived from his lectures there; and he made an acknowledgment of this fact in dedicating the second edition of his botany to the president and professors, when he said: "The science of botany is indebted to you for its first introduction into the interior of the Northern States, and I am indebted to you for a passport into the scientific world." In the course of two or three years, says Prof. H. B. Nason, to whose Biographical Record of the Rensselaer Polytechnic Institute we are most largely indebted for the material for this sketch, "Prof. Eaton diffused a great amount of knowledge on the subjects of his lectures; and so far excited the curiosity and enthusiasm of many young students that there sprung up, as a result of his labors, an army of botanists and geologists." The late Prof. Albert Hopkins, of Williams College, accrediting Prof. Eaton with being one of the first to popularize science in the Northern States, mentioned as among his special qualifications for the task an easy flow of language, a popular address, and a generous enthusiasm in matters of science, which easily communicated itself to his pupils. He adds: "Prof. Eaton was among the first in this country to study nature in the field with his classes. In pursuance of this idea, he used to make an annual excursion with Rensselaer School, sometimes leading these expeditions in person, at others deputing some competent teacher to take the lead. The cause of natural history in Williams College owes, undoubtedly, a good deal to Prof. Eaton. I think his zeal in the department of botany led Prof. Dewey to direct his discriminating mind to the study of plants, a study which he pursued farther than Prof. Eaton had done in certain lines. . . . At this time, also, Dr. Emmons took the field. In fact, natural history came on with the spring-tide, and has never lost the impulse since." While at Albany, in 1818, on the invitation of Governor Clinton, delivering a course of lectures before the members of the Legislature of New York, Prof. Eaton became acquainted with many leading men of the State, and interested them in geology and its application by means of surveys to agriculture. Here was planted the idea which eventually fructified in that great work, The Natural History of New York. In the same year Prof. Eaton published his index to the Geology of the Northern States, which has been pronounced "the first attempt at a general arrangement of the geological strata in North America." Although under the undeveloped condition of geology at the time, with the defective knowledge even among its advanced students, this book could not fail to contain many statements now known to be errors, it must be recognized as a creditable and valuable effort. An interesting view of the conditions of geology at the time and of the method of study is given in a letter which Prof. Eaton wrote to Mr. Henry R. Schoolcraft, in 1820, while preparing a second volume of the index. In it he said: "I have written the whole over anew, and extended it to about two hundred and fifty pages, 12mo. I have taken great pains to collect facts in this district during the two years since my first edition was published, but I am rather deficient in my knowledge of secondary and alluvial formations. I wish to trouble you with a few inquiries on that subject. From what knowledge I have been able to obtain in that department, I am inclined to arrange the secondary class thus: Breccia, compact, or shell limestone; gypsum, secondary sandstone. I leave much, also, for peculiar local formations. A gentleman presented specimens to the Troy Lyceum, from Illinois, of gypsum and secondary sandstone, and informed me that the latter overlaid the former in regular structure. Myron Holly and others have given me similar specimens, which they represent as being similarly situated, from localities in the western part of this State. This secondary sandstone is sometimes more or less calcareous. I believe it is used for a cement by the canal company, which hardens under water. Will you do me the favor to settle this question? On your way to Detroit you may perhaps, without material inconvenience, collect facts of importance to me in reference to secondary and alluvial formations. Anything transmitted to me by the middle of April on these subjects will be in season, because I shall not have printed all the transition part before that time. Have you any knowledge of the strata constituting Rocky Mountains? Is it primitive, or is it graywacke, like Catskill Mountains? I have said in a note that after you and Dr. E. James set foot upon it we shall no longer be ignorant of it. I intend to kindle a blaze of geological zeal before you return. I have adapted the style of my index to the capacity of ladies, plow-joggers, and mechanics."

Prof. Eaton also delivered lectures at Lenox Academy and the Medical College at Castleton, Vt., where he was appointed Professor of Natural History in 1820. He gave lectures and practical instructions in Troy, and thus laid the foundation for the establishment there, as a direct result of his work, of the Lyceum of Natural History; and it is said that in the fall of 1818 Troy could boast of a more extensive collection of American geological specimens than could be found at any other literary institution in this country. The geological and agricultural survey of Albany and Rensselaer Counties, made in 1820 and 1821, by Prof. Eaton and Drs. T. Romeyn and Lewis C. Beck, at the expense of the Hon. Stephen Van Rensselaer, is believed to have been the beginning of such surveys in this country, and was described by Prof. Silliman, in his Journal, as a novel attempt. Next was a geological survey by Prof. Eaton, also at the instance of Mr. Van Rensselaer, of the district adjoining the Erie Canal, the result of which was published in 1824, in a report of one hundred and sixty pages, with a profile section of rock formations, from the Atlantic Ocean, across Massachusetts and New York, to Lake Erie. Governor Seward said of this work, in the Introduction to the Natural History of the State of New York, that it "marked an era in the progress of geology in this country. It is in some respects inaccurate, but it must be remembered that its talented and indefatigable author was without a guide in exploring the older formations, and that he described rocks which no geologist had at that time attempted to classify. Rocks were then classified chiefly by their mineralogical characters, and the aid which the science has since learned to derive from fossils in determining the chronology and classification of rocks was scarcely known here, and had only just begun to be appreciated in Europe. We are indebted, nevertheless, to Prof. Eaton for the commencement of that independence of European classification which has been found indispensable in describing the New York system. . . . Prof. Eaton enumerated nearly all the rocks in western New York, in their order of succession, and his enumeration has, with one or two exceptions, proved correct. It is a matter of surprise that he recognized, at so early a period, the old red sandstone on the Catskill Mountains, a discovery the reality of which has since been proved by fossil tests."

In 1824 Prof. Eaton was placed at the head, as "Senior Professor," of the School of Science founded by the Hon. Stephen Van Rensselaer at Troy, N. Y., then called the Rensselaer School, now the Rensselaer Polytechnic Institute. He spent the remainder of his life in this position. He introduced and developed here a system of instruction in which the students were made experimenters and workers, and, in place of recitations, delivered lectures to one another. The success of this method was such that some one or other of its features were introduced into other schools.

Summarizing his career in brief, Prof. Nason says, in his biography in the Rensselaer Polytechnic Institute Record: "In developing the botany and geology of the Northern States, Prof. Eaton rightfully ranks among the pioneers of the new era of the natural sciences in this country. His efforts in various departments of natural history were a rich gift to New England, New York, and even to the whole country, for which the country owes him a debt of gratitude. Many of his pupils have been for years among the most justly distinguished scientific men of the country. As an educator and an active laborer in the general cause of natural history in America, his memory will long be cherished. The history of natural science on this continent can never be faithfully written without giving the name of Amos Eaton an honorable place. It was he, more than any other individual in the United States, who, finding the natural sciences in the hands of the learned few, by means of popular lectures, simplified text-books, and practical instruction, threw them broadcast to the many. He aimed at a general diffusion of the natural sciences, and nobly and successfully did he accomplish his mission."

Prof. Eaton is described as having been a kind and courteous gentleman, whose vast acquirements and simple habits were pleasantly characterized by Mrs. Emma Willard's designation of him as "the Republican Philosopher." Three of his sons adopted scientific pursuits or cultivated scientific tastes. One, Hezekiah Hubert Eaton, was Assistant Professor of Chemistry in Transylvania University, but died when only twenty-three years old. Major-General Amos B. Eaton was an officer of the United States Army and interested in science. A daughter, Sara C. Eaton, was a teacher of natural sciences and the modern languages in a young woman's seminary at Monticello, Ill. A grandson, Prof. Daniel Cady Eaton, has been Professor of Botany in Yale College since 1864.

The list of Prof. Eaton's books includes an Elementary Treatise on Botany, 1810; Manual of Botany, 1817; Botanical Dictionary, 1817; Botanical Exercises, 1820; Botanical Grammar and Dictionary, 1828; Chemical Note-Book, 1821; Chemical Instructor, 1822; Zoölogical Syllabus and Note-Book, 1822; Cuvier's Grand Division, 1822; Art without Science, 1800; Philosophical Instructor, 1824; Directions for Surveying and Engineering, 1838; Index to the Geology of the Northern States, 1818; Geological and Agricultural Survey of the County of Albany, N. Y., 1820; Geological Nomenclature of North America, 1822; Geological and Agricultural Survey of the District adjoining the Erie Canal, 1824; Geological Text-Books, prepared for Popular Lectures on North American Geology, 1830; and Geological Text-Book, for the Troy class, 1841.

Speaking of the practical teaching of geology, in his address in the British Association, Prof. A. H. Green took up the case of places where it is hard to find within manageable distance of the school the kind of field geology which is within the grasp of a beginner. Even here the teaching need not be wholly from books. Object-lessons may be given indoors. "For instance, give a lad a lump of coarsest sandstone; let him pound it and separate by elutriation the sand-grains from the clay; boil both in acid, and dissolve off the rusty coating that colors them; ascertain by the microscope that the sand-grains are chips and not rounded pellets, and so on. All such points he will delight to worry out for himself; and, when he has done that, an explanation of the way in which the rock was formed will really come home to him. Or it is easy to rig up contrivances innumerable for illustrating the work of denudation. A heap of mixed sand and powdered clay does for the rock denuded; a watering-can supplies rain; a trough, deeper at one end than the other, stands for the basin that receives sediment. By such rough apparatus, many of the results of denudation and deposition may be closely imitated, and the process is near enough to the making of mud pies to command the admiration of every boy. . . . The great facts of physical geology, which have so important a bearing on geology and history too, often admit of experimental illustration, such, for instance, as the well-known methods of imitating the rock-folding caused by earth-movements."

CORRESPONDENCE.

PUPILS OR MACHINES?

Editor Popular Science Monthly:

THAT the present system of graded schools is far in advance of the old ungraded one, where the same teacher instructed Johnny in his A, B, C, and Johnny's older brother in geometry, is an undeniable fact. But to the non-professional observer, who merely looks at the effect on the children, it is by no means evident that the reaction against the schools of fifty years ago has not gone too far. By the present mode of specialization, many individual teachers have worked out their own hobbies, and presented their arguments so plausibly that they have gained general acceptance. Each succeeding year shows a so-called advance in these "natural" methods, and they are all united in a system so unnatural that a course of it kills out all individuality in the child mind and life, and leaves us with a set of little machines, all stamped out from the original metal with the same die.

Look, for a moment, at some of the methods employed in our schools, examples taken at random, and that ought to speak for themselves. First comes a city grammar-school, where the pupils average thirteen years of age. To save herself the trouble of speaking the names of her children, the enterprising teacher has arranged these names in alphabetical order, numbered them according to this order, and addresses the pupils as "Number Two," "Number Twenty-eight," "Number Forty-three." Slight as this fact may seem, it is not without its influence. From ceasing to have any names of their own, as far as their teacher is concerned, the children cease to have any personality in her eyes, and the pupil becomes a mere hollow block, labeled with a certain number, into which daily portions of arithmetic, geography, and grammar are to be poured, regardless of the capacity of the block and the strength of its walls to resist overpressure. The child keenly feels such loss of individuality, and, by this loss, much of the incentive to work is withdrawn.

As for the lessons themselves, much fault lies at the foundation of all learning to read. While our parents were forced to spell columns of words, real or imaginary, like *am*, *bam*, *cam*, *dam*, and so on to *zam*, and, by perusing such cheerful sentences as "the lamb is on the tomb," to discover that in some words the final letter *b* is superfluous, as an improvement on that the children of to-day are taught to read without spelling, recognizing each word by its appearance, and learning it as a detached fact. The time spent in gaining a vocabulary in this way would surely be more than sufficient to teach the child the separate letters and their usual combinations, and his reasoning powers would be quite as rapidly developed in the latter case.

A lesson in writing was recently witnessed with some amusement and perplexity. One of the pupils took her place at the piano, while the teacher gave these brief orders: "Attention; sit erect; feet together; lean forward; elbows on desks; curve two fingers; hold pen; describe letters in the air." And, while the piano rattled out a gay march or a lively waltz, fifty arms were waved in mid-air, vaguely outlining a string of letters. Again the voice was heard: "Stop; dip pens; write on paper; begin." And then capital I's were scratched off by the score, while the waltz sounded its accompaniment. Then came the command, "Wipe pens." Alas for the luckless child whose pen was not dipped deeply enough, or caught a thread on its tip! On, on he must go, until the order "Dip pens" or "Wipe pens" gave him a chance to repair his accident. The avowed object of all this is to teach the rapid writers to take more time, while those who are slower with their pens must learn to hurry. Why is this necessary? And if the lessons of school are to prepare one for the every-day needs of life, it would be the natural conclusion from this that our business men have grand pianos and church organs in their offices and counting-rooms, and that the clerks take turns in playing appropriate selections from the old masters.

But two more strange rules can be glanced at. By the first, each child in a certain public school must take home one book every night, no matter whether the lessons are all prepared or not. The other, which, like the first, comes to us from Massachusetts, is still more absurd. In this case the text-books are free, and each book has a string securely tying down the leaves not yet studied. On no account may a child slip out a leaf and look ahead. The object of this last regulation is still unknown; but for most teachers it is safe to assume that when a child wishes to learn a fact, then is the best time to teach him regarding it.

Is not the present craze for carrying "methods" to extremes worthy of some consideration? ANNA CHAPIN RAY.

WEST HAVEN, CONNECTICUT.

ANTISEPTIC TREATMENT AND SIR JOSEPH LISTER.

Editor Popular Science Monthly:

IN the short list of important discoveries of the last fifty years, given in the July number (p. 428), that of the antiseptic treatment is omitted. Dr. Lister, now Sir Joseph Lister, realizing that inflammation and suppuration of wounds (whether caused by accident or the kindly knife of the surgeon) proceeded from noxious spores settling in exposed parts of the flesh (as taught by Pasteur), arranged methods by which none of these germs might light upon the wound, or, if they did alight, that they might be killed. This, the antiseptic or germicide system, gives the modern surgeon, with the use of anæsthetics, such a command of circumstances that he can amputate a limb or explore interior parts of the body with an impunity almost miraculous. The wound that, in former times, almost inevitably suppurated, is now protected from serving as a fertile ground for germs that but a few years ago would have settled there and multiplied enormously. The presence of these bacteria produced the inflammation, and thereby much of the vital force of the patient was expended in the process of recuperation from a trouble which was but a sequel to the wound. Now, every skillful surgeon protects his patient from these spores, and, binding up the exposed flesh with antiseptic bandages, the wound heals rapidly without secondary symptoms. The existence of inflammatory gangrene in hospitals ought to be forever exorcised.

To religiously prominent men are built shrines, even though they did not perform miracles either during their lives or after death. But there will be no need to visit Lister's tomb; for the almost miraculous benefits he has conferred upon us can be obtained at the uttermost ends of the earth. Votive offerings innumerable might well be made to one who, if not listed among the saints, has rendered an inestimable service to mankind.

The English Government created Dr. Lister a baronet, though he was, in the estimation of many, as deserving of a higher title as any upon whom such honor is conferred. The Germans accepted his teaching promptly and cordially, and, when he visited Germany, awarded him a grand ovation. The American physicians adopted Sir Joseph's ideas, and have, perhaps, improved upon his system. It is now appropriate that the laity of all nations should recognize his most valuable teachings, and raise a sum of money to create, say, an endowment for original research to be named for the baronet.

Yours truly, Horace J. Smith.

Pontresina, Switzerland.

EDITOR'S TABLE.

HINDRANCES TO SCIENTIFIC PROGRESS.

AN exceedingly useful address was that delivered this year at Indianapolis, by Prof. T. C. Mendenhall, as retiring President of the American Association for the Advancement of Science. We publish it in our present number, and trust it may be widely read and carefully pondered. In Prof. Mendenhall's opinion the relations between the scientific few and the non-scientific many in this country are not as satisfactory as they ought to be. He finds that, though individuals here and there are disposed to be very liberal in the endowing of scientific schools and colleges, and though science is professedly held in very high honor, the community at large hardly seems to know how to distinguish between a true man of science and a *dilettante* or charlatan. In many cases the latter more easily secures attention and credence than the best qualified scientific specialist. He finds, too, that scientific methods of thought are not permeating the community to the extent that might be expected, considering all that is said in praise of science and the extensive provision that is already made for imparting a knowledge of its principles. What are the obstacles that stand in the way of more favorable results? That is the question which Prof. Mendenhall applies himself to answer. He thinks there are faults both on the scientific and on the non-scientific side; and not being able to deal exhaustively with the whole question, he properly confines himself to indicating the faults with which his own side, the scientific fraternity, may properly be considered chargeable.

The main fault all through, however its phases may vary, is that men of science, or many of them at least, are not sufficiently practical in their views and aims. They allow a great gulf to form between themselves and the non-scientific world, and regard the phenomenon with indifference or even with complacency. They have an infinite contempt for any science that aims at being popular; and we are not sure that the efforts we have ourselves made to interest the public in scientific subjects have not encountered in certain quarters a high disdain. Prof. Mendenhall, who may be trusted to know whereof he speaks, asserts that some men in their scientific disquisitions are "guilty of the crime of unnecessary and often premeditated and deliberately planned mystification." Think of it for a moment—a man of science aiming not at being as lucid as possible, at bringing his ideas within the comprehension of as large a number of persons as possible, but contrariwise trying to achieve the maximum of obscurity and the maximum of intellectual exclusiveness! The thought is really a painful one; and yet we may profitably dwell upon it, for it shows that scientific knowledge, like any other form of power, needs to be humanized if it is not to degenerate into a selfish and pretentious tyranny. One thing which must always be set to the credit of the founder of the Positive Philosophy is that he clearly saw the risk which pure science ran of losing itself in all kinds of refinements and specializations, and utterly ignoring social claims and interests. Many are the passages in which he has raised a note of warning on this point; and to-day we have the President of the American Association for the Advancement of Science telling us how seriously the warning is needed.

How are we to bring down our speculations and researches to the level of popular comprehension?—some of the mystifiers referred to by Prof. Mendenhall will probably ask. Nobody wants you, we reply, to bring down to popular comprehension that which can not possibly be popularly comprehended; but we do want you to have, and show that you have, an interest in the general advancement of knowledge, and that you regard your specialty, whatever it may be, as simply a higher development of forms of knowledge that are within the popular grasp, and as being, if remotely, still vitally, connected with the practical concerns of life. If such is not the case, if, on the contrary, you are soaring in a region in which practical views have no place and no possible relevancy, then we make bold to say that your so-called science is merely a laborious and pretentious idleness. It is one thing to wander far afield in search of that which may at some time or another, if not immediately, prove of value to the human race. It is another and very different one to wander far afield for the acknowledged purpose of getting, not only beyond general comprehension, but beyond the sphere of all possible utility. The only condition on which science can claim the reverence of mankind is that it devote itself to human service, and it rests with the serious students of science to make good this claim. In order that the relations between science and the age may be what they ought to be, the world at large must be made to feel that science is, in the fullest sense, a ministry of good to all, not the private possession and luxury of a few, that it is the best expression of human intelligence and not the abracadabra of a school, that it is a guiding light and not a dazzling fog. Prof. Mendenhall's address testifies that things are not on a right footing at present, but we may hope that those who have it in their power to bring about the change that is desirable will be influenced by his appeal to exert themselves for that purpose. We hear a great deal nowadays about the responsibility attaching to the holders of wealth. It is often said that wealth needs to be "moralized." Prof. Mendenhall makes it plain that knowledge needs to be moralized through the awakening of the holders of knowledge to a sense of *their* social responsibility. Whether knowledge indeed is not more in danger than capital of throwing off social restraint is quite an open question.

Prof. Mendenhall touches a very important point when he speaks of the unfortunate absence of the scientific element from our political life. There may be, doubtless there are, causes for this for which men of science are not to be blamed; but still it is a fact that a man of science is commonly looked upon as a man inapt for affairs. In the British Parliament science is represented by such men as Sir Henry Roscoe, Sir John Lubbock, Sir Lyon Playfair; literature and philosophy by Mr. John Morley, Mr. Balfour, and Mr. Gladstone, to mention but a few names out of many; and no one will question that the presence of such men raises the intellectual tone of any assembly in which they sit. In this country we seem to have no use for men of science and not much even for *littérateurs*. The consequence is that with us political discussion shows a total lack of breadth and an almost total lack of conviction. A tariff bill is the occasion for a simple tug-of-war, not for discussion in the true sense. Time was, as Prof. Mendenhall points out, when our politics could show such names as Franklin, Jefferson, Adams, and Hamilton—men strongly tinctured with philosophy and at the same time of high practical intelligence. Why should the Republic not have to-day the services of its most thoughtful sons? While the thought of the age is rising why should our politics grovel? When so many practical problems of the gravest moment are pressing for settlement, why should the very men whose habits of mind best fit them for social service retire, as it were, to a Sacred Mountain of their own and leave the field of civic activity to sentimentalists and adventurers? To answer these questions or to attempt to answer them would require more space than we command. Suffice it to say that these things should not be, and that much harm will result if they should remain as characteristic features of our civilization. Our chief hope lies in the adoption by the scientific class of that new and better view of their duties and functions indicated by Prof. Mendenhall. There is not much use in preaching to large masses, but small bodies may be more easily influenced; and it hardly seems an impossible thing that the corps of scientific workers should be penetrated by a new sense of social duty and should resolve to keep in closer touch with the people than heretofore. What gives the clergy of the several churches their undoubted influence? It is that they are with the people and of them. If they deal in mysteries, those mysteries are not their private property: whatever benefit or grace they yield is available for all. The mysteries of some of our scientists, on the contrary, far from being for all, are prized in direct proportion to the fewness of those who can take any part in them. The soaring specialist is never satisfied till he stands on a pinnacle so small that no one can get footing beside him.

We need hardly say that we find in the address of Prof. Mendenhall an abundant justification of the work in which we have been engaged now for a long term of years—the work of bringing home the best and surest results of science to a popular circle of readers and of keeping up as active a connection as possible between true scientific workers and the public. To this work we shall apply ourselves in future with increased courage and determination—increased courage from the hope that the stirring words of the retiring President of the American Association will bring us new allies and helpers; increased determination from a quickened sense of the need of just such work. It is no new dogmatism that the times call for, but a new spirit of helpfulness and hopefulness guided by science. By this means, and this only, will the world solve its problems and outride the storms that threaten its civilization.

THE LIBRARY AS A LABORATORY.

WHAT the old proverb says of fire—that it is "a good servant but a bad master"—might with truth be applied to books. It was the great defect of the old-fashioned education that books were allowed to get the mastery over the pupil. But now, that the immediate study of things has gained the ascendency in the modern mode of teaching many subjects, care must be taken not to run into the opposite extreme, and disregard books altogether. How much aid a well-managed collection of books can give to the student in any field is clearly pointed out by Mr. George Iles in an article on The Library in Education, published in The Week, of Toronto. He says that, "although deposed from the supreme station they once held, they now occupy a place but little lower, and a place broadened by the scope of ideas new in education. Every important observation, experiment, experience in any of the unnumbered fields of science, or of teaching, soon gets itself printed in a book. Thus printed, it is in no sense a substitute for individual use of eyes, hands, and brain, but gives all these information, guidance, suggestion, of worth incalculable. . . . While in the study of architecture, geology, or engineering, the library is of increasing worth as an aid to work and practice, there are fields of research where it becomes the workshop itself. Research in law, history, philosophy, economics, literature generally, can only be pursued where books are gathered together and rightly ordered." The phrase "rightly ordered" is an allusion to the immense increase of value that librarians are now giving to the collections in their charge through improved organization. Formerly the librarian deemed his duty done if he faithfully guarded the books in his care from loss or injury, and the less they were used the less apprehensions he had for their safety. The librarian that is now coming to the front is a being of a different kind. He is trained for his profession, and he has a much broader conception of the work that belongs to him. "The new idea is," says Mr. Iles, "that he shall so vitalize his library, that to make his books attractive and useful shall be his chiefest care. To that end he must know how to order them and indicate their contents, so that the whole capital intrusted to him shall be instantly available for any inquirer's purpose. He must be able to give seekers guidance, have the tact and sympathy to stimulate research, the kindly enthusiasm which promotes study by inviting it to helpful stepping-stones." A library under such management rises to the plane of efficiency occupied by the laboratory. A modern laboratory designed for students in one of the sciences, with its convenient desks, drawers, and lockers, its rows of bottles containing reagents, its apparatus especially devised for the work to be done, its arrangements for water, gas, and steam, its compartments set off to secure special conditions of light, air, or temperature, and its collections systematically arranged for the comparison of specimens, is a most satisfactory place to work in To say that the modern library is approaching this character is the highest praise that we can give it.

Mr. Iles devotes the rest of his article to paying a well-deserved tribute to Mr. Melvil Dewey, now Secretary to the Board of Regents of the University of New York, and Librarian of the State Library at Albany, as being one of the leading spirits in bringing about modern reforms in library administration. Before going to Albany, Mr. Dewey was for five years Chief Librarian at Columbia College, during which time he produced there one of the finest examples of a modern working library. The Columbia College Library is open all day and in the evening throughout the year, except Sundays and Good Friday; it has a card-catalogue, which is the only kind that can be kept constantly up to date; in this catalogue the titles are arranged by subjects, so that the resources of the library in any field of knowledge can be seen at a glance; the books are arranged in the same way, so that the readers, who have free access to the shelves, can find the material relating to each topic of study all in one place; there is a large, light, and airy reading-room with an electric lamp on every table; the method of calling for books gives the least possible trouble to the reader; those lent out are charged under a system which enables the charging clerk to tell the whereabouts of every volume at any time; trained librarians are always at hand to give any assistance needed, and users of books are afforded other facilities too numerous to mention. The improvements in this library made by Mr. Dewey induced several societies to deposit their special libraries here permanently, and drew in so many gifts that the collection grew as much in five years as it had during the preceding century. In such a library we have the same thorough adaptation of resources to the work to be done that characterizes the laboratory. Similar methods are spreading widely among libraries designed for study, and promise to give books a higher value and a truer usefulness than they ever had when they were the objects of a sort of fetich-worship.

LITERARY NOTICES.

American Spiders and their Spinning-work. By Henry C. McCook, D. D. Vol. II. Published by the author: Academy of Natural Sciences of Philadelphia. Pp. 480, quarto. Price, $30 for set of three volumes.

The high character of the first volume of this work is fully kept up, if not excelled, in the second. We have here the same careful observation that marked the first volume, the same painstaking description, the same clear and picturesque language, and more than an equal wealth of illustrations, for, in addition to the four hundred cuts, Volume II contains five colored plates. These last may be taken as samples of those that are to form so large a feature of the concluding volume. Upon the completion of Volume III, which is now well under way, the price of the set will be raised to $50. This has been found necessary, in order to reimburse the author for the cost of publication. The early portion of the present volume is devoted to the courtship and mating of spiders. Here are described the search of the male for a mate, his approaches, made cautious by the knowledge that his prospective bride may eat him if she does not feel amiable, his actions in the union, and his flight for life afterward. The males of some species execute curious dances to win the favor of the females; the water-spiders have special habits of mating due to their mode of life; and various other peculiarities are observed in other species. Maternal industry and instincts are next taken up, this subject comprising the making of cocoons, and the means employed to protect their contents from exigencies of climate and weather, and assaults of enemies. The habits of orb-weavers are taken as the basis of the account, but the cocoonery of many other species is fully described for the purpose of comparison. The early adventures of the young form another phase of spider-life that receives similar detailed attention. One of the most interesting chapters is that dealing with the ballooning habit of spiders, or their practice of sailing through the air borne up by several streaming threads. The habit is by no means confined to one species, Dr. McCook deeming it probable that the young of most spiders are more or less addicted to this mode of motion. There is a chapter on the senses of spiders, in which the anatomy of the sense-organs is described. In speaking of color and the color-sense, Dr. McCook contradicts the popular idea that spiders as a class are ugly, and says that as fair and brilliant colors may be found among the spiders as among the butterflies. Other topics treated are the influence of hostile agents in causing mimicry on the part of spiders, in modifying their habits, and in causing the feigning of death. Dr. McCook does not accept the theory of fear-paralysis as regards spiders, but believes that their assuming of death-like stillness in the presence of stronger enemies is entirely voluntary. The bodies of spiders are so easily destroyed that many readers will be surprised to find a chapter on fossil spiders in this book; yet thirty-two species have been found in America and one hundred and ninety in Europe. Of these European spiders one hundred and sixty-eight were preserved in amber. In the course of this volume the author has been brought in contact with many of the modern problems of biology. He has not taken sides in any controversies, but the facts that he has recorded concerning the araneads can not fail to throw light on some of the matters in dispute. His contributions to science, already notable, are made much more so by this splendid work; and when it is remembered that his observations have been made in the moments that could be spared from a busy professional life, his achievements excite wonder as well as admiration.

School Supervision. By T. L. Pickard, LL. D. New York: D. Appleton & Co. Pp. 175. Price, $1.

Not only superintendents and teachers, but all those concerned in the management of children, will find helpful hints in this volume. It is the outcome of twenty years of keen observation in the superintendency of schools, such excellent oversight that Dr. Harris writes of it, that "In the visits of inspection made to the principal cities of the country in the decade 1867 to 1876 . . . he found no system to compare with that of Chicago while under the supervision of Mr. Pickard." The first subjects treated are the qualifications and duties of the superintendent in the State, the county, and the city. The work of the State Superintendent is largely advisory; he needs to be upright, broad-minded, forcible, and judicial. The county superintendent comes closer to the school-room, while the city superintendent finds his chief duty supervision of instruction. The relation of the superintendent to pupil, teacher, parent, and Board of Education is considered in special chapters. In discussing courses of study, a vigorous argument for the high school is given. The author points out in the preface that his views of promotions and examinations have changed materially in later years. "Examinations appear too frequently as the end of school-work rather than as a means to an end. So prominent has been the error, and so ruinous its acceptance, that wise men are tending to an opposite extreme." Other important topics which receive attention are physical training, moral training, and government of pupils.

Two obstacles to the progress of the public schools are noted: "1. The large proportion of inexperienced teachers employed. 2. The lack of professional spirit." About twenty-two per cent of new teachers are required annually. The majority are women who make teaching a temporary matter rather than a life-work. To effect a change the superintendent must meet the old theory that "'competition determines wages,' with the newer theory that salary is attached to place and not to person, and, where places are vacant, the most competent persons available should be called to fill them without regard to sex." Professional schools are needed as well as advancement in normal schools. Among the means suggested for the improvement of teachers are teachers' meetings, the use of good periodicals, and "lines of study outside of school-work," such as scientific societies and summer schools afford. The book contains besides an index two appendices—one in which a strong plea is made for moral influence in the school, and another devoted to a study of boys.

Hypnotism. By Albert Moll. The Contemporary Science Series. New York: Scribner & Welford. Pp. 410. Price, $1.25.

While this subject is doubtless still in its infancy, it has already engaged the efforts of so many and so able investigators, and has aroused such a wide popular interest, that no list of books on the science of the time would be complete without a treatise upon it. Dr. Moll's book is a survey of the whole subject, adapted to the general reader. The author passes over the history of hypnotism very briefly. His method of giving the reader an idea of the phenomena of hypnotism is by relating several experiments, and this leads to a short consideration of the methods of inducing hypnosis, who can be hypnotized, and what distinct stages of hypnosis there are. On this last point Moll accepts provisionally a classification lately published by Max Dessoir, dividing the states into two large groups, which are distinguished thus: "In the first group merely the voluntary movements show changes; in the second group abnormities in the functions of the sense organs are added. In the first group, also, only those functions are abnormal which we attribute to the centrifugal nerves, while in the second group the functions of the centripetal nerves are likewise disturbed." The longest and most important chapter in the book is that on the symptoms of hypnosis. These he arranges under the headings Physiology and Psychology, but merely for convenience, as the bodily functions become abnormal only in consequence of changed mental states. The physiological symptoms concern "the voluntary and involuntary muscles, the organs of sense, common sensation, the secretions, metabolism, and, in rare instances, also the cell-power of organization." As to whether reflex movements that do not appear under normal conditions appear in hypnosis, as Charcot and Heidenhain assert, the author is inclined to say "not proven." Under psychology he names abnormity of the memory, the performance after being wakened of actions suggested during hypnosis, the habit of hypnotics trying to find reasons for absurd suggested acts, etc. In his opinion we can not speak of loss of consciousness in hypnosis, nor is the subject devoid of will power, as is often shown by resistance to suggestions. In concluding this division of the subject, Dr. Moll delivers a caution against mistaking the results of training for essential hypnotic phenomena. For instance, Delbœuf artificially induced the stages of Charcot in one of his own subjects in a few hours. A discussion of states cognate to hypnotism follows. Dr. Moll begins by saying, "I do not think we can make a close comparison between sleep and hypnosis," but seems to contradict himself by stating, in conclusion, that "hypnosis by no means needs to be sharply distinguished from sleep." Next the author takes up the theory of hypnotism, and passes in review the various actions in the brain that have been supposed to account for hypnotic phenomena. He gives a little attention to the subject of simulation, because disbelievers in the reality of hypnotism are very fond of crying fraud. He also considers respectively the medical and the legal aspects of hypnotism in a suggestive style, and closes with a tolerant glance at the alleged phenomena of animal magnetism, telepathy, etc. Two indexes and a short list of the books the author chiefly recommends are appended to the volume. The author is himself an experimenter and frequently alludes to his own results, but his tone throughout is that of a judge rather than that of the advocate of any special theory. His pages bristle with parentheses, inclosing names of men to whom he credits observations and opinions. The work claims to be thoroughly up to date, it gives evidence of having been carefully written, and it has already had the benefit of one revision.

Practical Sanitary and Economic Cooking adapted to Persons of Moderate and Small Means. By Mrs. Mary Hinman Abel. American Public Health Association: Rochester, N. Y. Pp. 182. Price, 40 cents.

This little work is the essay for which was awarded the prize of five hundred dollars offered by Mr. Henry Lomb, of Rochester, in 1888. Its great superiority over the other essays offered in the competition may be inferred from the fact that no one of the other sixty-nine was adjudged worthy of the second prize of two hundred dollars offered at the same time. The basis of the treatise is an explanation of what is meant by food-principles, with the amounts of each that are required by a man, a woman, and a child, respectively, and the percentages to be found in different kinds and cuts of meat, in vegetables, etc. This theoretical matter is illustrated by practical directions for cooking all the reasonably economical foods. The recipes are grouped under the three headings, Proteid-containing Foods, Fats and Oils, and Carbohydrate-containing Foods. In describing methods of cooking meat, the author first answers the question—which probably few housewives have ever thought to ask—Why do we cook it at all? Several ways of cooking each kind are given, and the rank of each in the scale of economy is told. In the short chapter on Fats and Oils, the importance of fat in the diet is emphasized, and several ways of preparing cheaper fats so as to take the place of butter are described. The cooking of grains and vegetables, and the making of bread, fritters, and puddings, are described in like manner with the cooking of meat. Soups, being among the most economical of dishes, receive a large share of attention. The author advises the housewife to make use of the full range of seasonings at her command, so as to increase the number of stimulating flavors that can be given to the food of the family. In conclusion, there are given twelve bills of fare for a family of six, costing on the average seventy-eight cents a day, twelve costing one dollar and twenty-six cents, and twelve dinners to be taken by a man to his work and eaten mostly cold. Other topics, namely, drinks at meals, cookery for the sick, and the buying of meat, are treated, and the author has deemed a few words on the arrangement of the kitchen not out of place. Mrs. Abel's mode of presenting her subject is thoroughly scientific, and at the same time is attractive and encouraging, and not above the comprehension of an ordinarily intelligent woman, if she is not afraid of columns of percentages, and such words as "proteid" and "carbohydrate." The book is sold for a nominal price, in order that the information it contains may be widely diffused. It is published in both paper and cloth covers, and in the German as well as the English language, and may be obtained by addressing Essay Department, American Public Health Association, P. O. Drawer 289, Rochester, N. Y.

A Treatise on Massage, Theoretical and Practical. By Douglas Graham, M. D. Second edition, revised and enlarged. New York: J. H. Vail & Co. Pp. 342. Price, $2.75.

The history, mode of application, and effects of massage, indications and contra-indications, are also included in the title of this book. The author is known to the readers of the Monthly from his having published in it, in October, 1882, a description of General Massage, which was one of the fullest and most intelligible and satisfactory popular accounts of the subject that had till then been given, and which we believe did much to bring massage into general notice. The first edition of this work was published a little more than two years afterward, for the purpose of recalling the facts and observations scattered in numerous medical memoirs, and uniting them with the author's own experience. For the present edition, the work has been thoroughly revised, and enlarged with numerous additions, many of them confirmatory of statements previously regarded as doubtful. Two new chapters have been added—one on local massage for local neurasthenia, and the other on the treatment of scoliosis by means of massage. Much new and valuable information from European doctors is introduced on the uses of massage in affections of the ear, in scoliosis, in affections near and into joints, and in affections of the abdominal organs. The summary of the history of massage, to which two chapters are devoted, traces the development of the process from the rubbings of the most ancient times. According to Prof. Billroth, massage is as old as surgery itself—and that means as old as mankind. Rubbing is spoken of by Homer, and was practiced among the Greeks and Romans, by people of different classes, in their gymnasia and their baths, among whom it seems to have been highly appreciated by men of note, eminent as physicians or philosophers, poets or historians; and so it has come down to us—not been discovered. It is also familiar and efficacious among many barbarous and savage peoples. In the chapter on the mode of applying massage, the point is maintained that the matter should not be left to novices, to persons who "have a knack" for it, or to those who take it up without instruction, or with imperfect instruction, but is one in which intelligence and professional skill have an important place, and which doctors should not be above engaging in personally. The study of the physiological effects of massage is declared to be commensurate with that of physiology itself. It "rouses dormant capillaries, increases the area and speed of the circulation, furthers absorption, and stimulates the vaso-motor nerves. . . . Seeing that more blood passes through regions masséed in a given time, there will be an increase in the interchange between the blood and the tissues, and thus the work done by the circulation will be greater, and the share borne by each quantity less." The process is then shown, in particulars, to be beneficial in affections of the nervous system. In the succeeding chapters its application is discussed, with numerous citations of illustrative cases in each—which are preferred to deductions—in nervous exhaustion and anæmia, in affections of the uterus and other internal organs, in local neurasthænia, in affections of the central nervous system, in writer's cramp and allied affections; in neuralgia, peripheral paralysis, muscular rheumatism, muscular rupture, elephantiasis, œdema, scoliosis; in sprains and affections of the joints; in disorders of the head, face, eyes, ears, and throat, and in catarrhal affections.

Sanity and Insanity. By Charles Mercier. Contemporary Science Series. New York: Scribner & Welford. Pp. 395. Price, $1.25.

The author has endeavored, not so much to describe and enumerate, as to account for the phenomena of insanity. It is agreed that certain occurrences are occasional, others common, and others invariable in insanity, and that certain occurrences are frequently associated; but why such connections should exist has never been explained, nor, so far as the author knows, inquired into. Many hypotheses are experimentally applied in the pursuit of the inquiry thus outlined, without claiming that they are the true explanations of the facts, but because "at any rate, they are explanations of some kind," the author believing that the state of our science "has reached a point at which some explanation of the facts of insanity has become desirable, and that any hypothesis, even if erroneous, is a step toward the attainment of truth, and is better than a mere unorganized accumulation of facts." A more clear distinction is insisted upon than is observed by some physio-psychological writers—perhaps the careless ones—between nervous processes and the mental states that accompany them. While there is no thought or mental condition without a nervous process, the relation between the two is like that of a shadow, equivalent, obverse, or accompaniment of inexplicable association. It is found, in the search for a definition of insanity, that in every case of the affection three factors are present—"disorder of the highest nerve arrangements, disorder of conduct, and disorder of consciousness; and in every case the disorder of consciousness includes disorder of thought and of feeling, of self-consciousness, and of consciousness of the relation of self to the surroundings. In no two cases, however, are these various factors combined in quite the same way, and thus no two cases precisely resemble one another. On the way in which they are combined depends the form which the insanity assumes." Among the causes of insanity are those arising from heredity, which may work under the law of inheritance or under that of sanguinity, in which are involved the effects of different degrees of similarity or dissimilarity in parents; direct stress, or the action of noxious agents immediately on the nerve-centers; and indirect stresses—which are of internal origin when the agent is some commotion in the organ itself, as in the case of morbid affections; or of external origin, when the agent is some commotion in the environment, as when cares of family or business or social and political relations worry. The forms of insanity are various, and are hardly susceptible of a fixed classification. They may be arranged from different points of view, and may run into one another. The author treats idiocy, imbecility, sleep, old age, and drunkenness as being marked by one or more of the features that may enter into insanity, and discusses the forms of the real affection under the heads of melancholia, exaltation, and dementia. The discussion of the points brought up is lively and bold, and the observations upon them are pungent and often witty.

The Antiquities of Tennessee and the Adjacent States, and the State of Aboriginal Society in the Scale of Civilization represented by them. By Gates P. Thruston. Cincinnati: Robert Clarke & Co. Pp. 369, with Plates. Price, $4.

The author is Corresponding Secretary of the Tennessee Historical Society. He does not in this work expound a theory, but presents a series of historical and ethnological studies, very largely his own, but with those of others often brought in for illustration and comparison, the aim of which is to exhibit precisely the evidence which the mounds and their contents afford of the degree of civilization attained by the builders and the character of their social life. The book has grown out of the author's labors in describing the fine types of pottery and other objects found in the large aboriginal cemetery which was discovered near

Nashville about two years ago. The material worthy of illustration accumulated so rapidly that it was found impossible to do justice to it in the modest pamphlet that was contemplated. It became necessary, also, to consider the general subject of ancient monuments and antiquities in Tennessee, in order properly to introduce the new material discovered, and thus make the publication useful to a larger class of readers. The people whose relics are described here are called by the author the Stone-Grave race, because their dead were placed in cists or box-shaped graves built of stone slabs, and sometimes constructed with much care. A hundred or more of these graves are occasionally found, deposited in several tiers or layers, in a single burial mound. The utensils and treasures laid away with the bodies are generally well preserved, and "tell the story of domestic life in the Cumberland and Tennessee Valleys with remarkable exactness, and unravel secrets that the most imposing monuments of the native races have failed to disclose." Besides the graves, the remains of the forts, villages, and settlements of the same people have been discovered in considerable numbers; and, on the whole, Tennessee appears to have afforded one of the most fruitful fields that the American archæologist has been privileged to explore. The articles—inscribed stones, idols, images, totems, potteries, pipes, implements of chipped stone, smooth stone, copper, bone, and shell—betoken an artistic taste and technical skill beyond that of our Indians or of the mound-builders of the States farther north, and are more on the level of the best New Mexican work. Among the most remarkable of them are some finely finished large flints, from sixteen to twenty inches long, which the author designates as scepters, and others equal to them in degree, which he classifies as ceremonial implements. The most remarkable, perhaps, are the shell gorgets, carved with intricate figures, in which the human form may be discerned, the style of which suggests Mexican and Central American work. One of these, from the MacMahon Mound, Sevierville, represents two human figures in combat, and is regarded as the highest example of aboriginal art ever found north of Mexico. A unique stone in the collection of the Tennessee Historical Society has engraved upon it the representation of a group of mound-builders, with their banners, weapons, costumes, and manner of dressing the hair clearly shown. The author, who is an original investigator, and not liable to be deceived, vouches for the authenticity of all that he describes. A chapter is devoted to the study of the ancient houses, which are compared with those of the Mandans, and the aboriginal trade, which seems to have been co-extensive with the continent. In age the people were probably pre-Columbian, but may have lived down to the days of the Spanish explorers. In ethnic relations they were a branch of the general stock of our Indians, in a more advanced stage of civilization than any of them now are, but not in other respects differing more from them than some of the tribes differ from others.

The Criminal. By Havelock Ellis. Contemporary Science Series. New York: Scribner & Welford. Pp. 337. Price, $1.25.

Mr. Ellis has attempted in this work to present to the English reader a critical summary of the results of the science now commonly called criminal anthropology. The study of the problems of this science—which deals with the criminal as he is in himself and as he becomes in contact with society, and with the social bearings of the subject—has been carried on with great activity during the past fifteen years in many countries, and has given rise to a considerable number of elaborate and thorough-going treatises, most of which are inaccessible to general English readers, and, by reason of their magnitude or of the special, detailed character of the research, are not likely to become familiar. Mr. Ellis has reviewed them and picked out the conclusions to which they lead with much skill and apparently without prepossession in favor of any special theory. Besides doing his workman's work in a workmanlike manner, he has shown a capacity to handle the subject independently, as one who has made himself master of it, and has matured his own manner of regarding it. First, the chief varieties of the criminal are enumerated; the causes of crime are classed as cosmic—the influence of the external organic world; biological—the personal peculiarities of the individual; and social. The history of the study of criminality is next sketched, and its importance is indicated. The physical characters of criminals are considered and compared with those of other men, after the example set by Lombroso, with reference to various anatomical peculiarities as well as to the broader factors of general structure, physical sensibility, and heredity. Of psychical factors, moral insensibility, intelligence, vanity, emotional instability, sentiment, and religion are presented as those to the influence of which, on one side or the other, the most importance may be attached. The working of these factors is illustrated by reference to the custom of tattooing, thieves' slang, prison inscriptions, criminal literature and art, and criminal philosophy. The results of criminal anthropology are reviewed in the fifth chapter; they are sometimes obscure and even contradictory; but we can not afford, in dealing with criminals, to dispense with such science of human nature as we may succeed in attaining. The lesson is drawn that criminality is a natural phenomenon to be studied gravely and carefully, according to natural methods; and that by natural and reasonable methods alone can the problem of its elimination be faced with any chance of success. The general character of some of these methods is indicated.

Protoplasm and Life, one of the Fact and Theory papers series, published by N. D. C. Hodges, New York, contains two biological essays by *Charles F. Cox*. In the former essay, entitled The Cell Doctrine, the author reviews the history of the theory of protoplasm and the discussions upon it, and reaches the conclusions that the original idea of the cell, as propounded by Schleiden and Schwann, has gradually faded away; that there appears to be no one visible and tangible substance to which the name protoplasm is rigidly and exclusively applied; and that life is as much a mystery as ever. In the second essay, which is on the Spontaneous Generation theory, he endeavors to show that a transition from not-living matter to living forms is an essential step in the process of evolution; that at the point at which experimental proof is applicable (namely, present and continued archebiosis) the theory of such transition is discredited, if not disproved; and that "the general theory of evolution is still in the stage of hypothesis, and that in the gap between lifeless substances and living forms we have the veritable 'missing link.'"

In preparing his book on *Tornadoes* (New York, N. D. C. Hodges, Fact and Theory papers) Prof. *H. A. Hazen* has aimed to present in popular style the theories bearing on the subject, and the facts that have accumulated from year to year, otherwise scattered through many volumes. Efforts have been made to sift theories to their sources; to review Espy's work, which lies at the basis of modern theories of tornado formation; to obtain an estimate of the tornadoes that have occurred in this country since 1873; and to compare the destruction by tornadoes with that by fire. Some suggestions are given about tornado insurance. The sun-spot theory and the possibility of predicting tornadoes are touched upon. The Louisville tornado is described; and directions are given for observing tornadoes.

The *Chief Signal Officer of the Army* complains in his *Report* for 1889 that the military branch of the corps is deteriorating for the lack of facilities for the practical training and drilling of the officers and men, but makes a full exhibit of meteorological work. The issue of weather forecasts and storm warnings has been continued, and the demands for them have increased. As the field to which they are applied expands, modifications have to be made in their shape; they become more general, and local work has more to be left to local observers; and in this department obligations are acknowledged to certain newspapers in the larger cities. Defects in the predictions are excused by pleading the amount of work that is imposed upon the persons who have to make them. Thus the chief forecast official has forty-nine minutes in the morning and fifteen minutes at night at his disposal for what is a very complicated task. Yet, the percentage of correct predictions is rising —78·3 in 1887, 81·6 in 1888, and 83·8 in 1889. Weather reports from the West Indies have been resumed. A special study is being made of cold waves. Weather signals are supplied at 1,056 stations. Observations of atmospheric electricity have been discontinued, as not promising, under present conditions, to lead to valuable results. The weekly weather crop Bulletin has been continued, and its value has been appreciated. Special attention is given to the height of rivers at seventy places on twenty-six rivers.

The second volume of the report consists of a treatise by Prof. *Cleveland Abbe* of *Preparatory Studies for Deductive Methods in Storm and Weather Predictions.* Together with already known conclusions and principles, it brings forward many new results; discusses the relative importance of various forces and resistances, the prominent features of vortex motion, the turbulent flow of the atmosphere, and the dynamic origin of the diurnal variation of the barometer connected with it; gives much space to the vertical motion due to buoyancy, to the formation of clouds, and to the conclusions to be drawn from their study. It seeks for the source and maintaining power of the storm, and for the conditions that influence the movement of the storm center.

The *Reference Handbook for Readers, Students, and Teachers of English History*, by *E. H. Gurney* (Ginn & Co.), is a series of tables of the historical families of England. It gives the descent of William the Conqueror, of the kings of England and their families, the descent of the present reigning families, the nobility of England, counselors and statesmen from 1066 to 1889, the principal British writers, and the dates of principal events.

Mr. *John Kennedy*, author of the *Stem Dictionary of the English Language* (A. S. Barnes & Co.), has proceeded on the opinion that there is a more satisfactory and more useful way of enlarging one's vocabulary than by definition. The definition of a word built up out of a familiar primary word is superfluous, because the word explains itself. If we know the stem, we can readily determine the meaning of the words into which it enters. This leads to the study of stems and to the adoption of word-structure as the basis of elementary education. This book is prepared as an aid to the study. In it the principal stems of the language are presented in alphabetical sequence, together with the value of each; first the primary value, then the line of transition into the secondary or derived use. In connection with each stem is given a list of its principal applications, together with such parenthetical remarks as may be helpful in connecting the stem value with the present use of the word. The list is liberally illustrated with quotations from standard authors, showing how many of the words have been used in their writings. It is also freely garnished with notes that embody literary, scientific, or historical lore. The stem-list is preceded by a word list which may be consulted when the stem is to be found, and is followed by a list of prefixes.

The first six books of *The Annals of Tacitus*, edited by the late Prof. *William F. Allen*, has been added to the "College Series of Latin Authors" (Ginn, $1.65). About half of each page is occupied with notes, and an introduction of thirty-two pages embodies information about the works of Tacitus and their characteristics, Tiberius, the condition of the Roman Empire in his time, etc. Appended to the volume are some textual notes, an index of proper names, and an index to the notes.

The Pleroma (Putnam, $2.50) is an account of creation in blank verse, in which the author, Rev. *E. P. Chittenden*, combines the biblical story with the revelations of science. It is in what the author calls semi-dramatic form—that is, like the form of the second part of Faust, the characters, or "voices," being mostly angels, spirits, forces, forms, etc.

The question of reading the Bible in the public schools is briefly reviewed in an essay by *Joseph Henry Crooker* (Wisconsin State Journal Printing Company). The stimulus to the publication of this pamphlet was a recent decision by the Supreme Court of Wisconsin prohibiting the use of the Scriptures for religious instruction in the schools of the State, and a subsequent address by Dr. Bascom criticising such action. The author finds a "fundamental fallacy" in the claim that Bible reading can be warranted in the schools of a secular state. It is not read as literature, nor as history, but as a supernatural revelation. He considers the decree "a friendly act" toward the Bible, since it prevents the use of archaic texts and passages obnoxious to young minds. The conclusion is reached that not only is the decision of the court in accordance with the

Constitution of Wisconsin, but that it is illustrative of "the holiest motive of human affairs, . . . the sentiment of universal justice," and indicates the dawn of "the modern state."

A series of articles originally contributed to Science by *Oscar Browning* is republished in revised form by the Industrial Education Association, under the title *Aspects of Education.* In this a study is made of the theories of teaching that have influenced the world since the Reformation. These are resolved into three classes: *humanism*, or the study of language; *realism*, a study of things; and *naturalism*, training for the art of living. The author claims in favor of language study that weighing the shades of meaning in words cultivates a subtler tact than either mathematical reasoning or biological discrimination. The realistic method of teaching, although indebted to Comenius and Milton, received its greatest impetus from the examples of Pestalozzi and Froebel. "There is no fear that, in the present day, the learning of things instead of words will be neglected." It is observed that "natural education will always have advocates and apostles, especially in times when there appears to be a danger of over-refinement or overpressure; but the wise educationalist will turn to it as a repository of cautions and warnings rather than as an armory of weapons fit for fighting against the ever-present enemies of ignorance and sloth." The pamphlet concludes with a historical sketch of the English public schools. Winchester, Eton, Harrow, and Rugby still adhere to the classical curriculum, so that "a public school man means one who has been educated mainly in Greek and Latin." The suggestion is made anent the boarding-school system, that "an idea may grow up that the home is, after all, the best place for children."

Nos. 10 and 12 of *Quiz Compends* (Blakiston, $1 each), are at hand. The former is *A Compend of Chemistry*, inorganic and organic, including urinary analysis, by *Henry Leffman*, M. D., which has reached its third edition. It gives a cursory view of the field of general chemistry, dealing also with biological chemistry, and is intended to serve medical students partly or wholly in place of written lecture notes. As to changes from the preceding editions, the author says that he has endeavored to bring the work up to date, and has given more space to explanations of the nature and functions of acids and radicles. He has also treated the organic substitution compounds more at length.

No. 12 of this series has for its subject *Equine Anatomy and Physiology.* It is by *William R. Ballou*, M. D., and contains twenty-nine graphic illustrations selected from Chauveau's Comparative Anatomy. The facts and descriptions are given very concisely, and are arranged under heads and sub-heads, divisions of different ranks being distinguished by different type. In order that the eye may readily find any item of which the reader is in search, each sub-head begins a new line.

From the same publishers we have received the third edition of *The Essentials of Medical Chemistry and Urinalysis*, by *Sam E. Woody*, M. D. (price, $1.25). It contains more matter than the usual volumes of lecture notes, and may be described as a brief treatise. Directions for a considerable number of experiments are inserted in the form of foot-notes, and processes and arrangements of apparatus, etc., are shown in sixty-two cuts. The chapter on urinalysis is quite full, and contains figures showing the appearance under the microscope of various solid matters, crystalline substances, etc.

Also from the Messrs. Blakiston comes a little volume in the same style as the last, but much briefer, on *Electro-Chemical Analysis*, by Prof. *Edgar F. Smith* (price, $1). It is designed to make students acquainted with the methods of quantitative analysis by electrolysis. The author describes the plan of the book as comprising "a brief introduction upon the behavior of the current toward the different acids and salts, a short description of the various sources of the electric energy; its control and measurement; after which follow a condensed history of the introduction of the current into chemical analysis, and sections relating to the determination and separation of metals, as well as the oxidations possible by means of the electric agent. . . . The methods of determination and separation given preference are not those of any one individual, but have been selected from all sources after an experience of many years, care being taken to present only those which actual tests have shown to be reliable and trustworthy." The volume contains twenty-five illustrations.

A new and revised edition is published by William Wood & Co. of Mr. *Henry Kiddle's Text-Book of Physics*, in which are incorporated the alterations needed to adapt the book to the present state of science. The work itself is an adaptation or simplification of Ganot's work, and regard has been had, in carrying out the revision, to the changes and improvements that have been made in the successive editions of the prototype. A large number of experiments, with new illustrations, have been added in the department of "Application of Principles."

Health for Little Folks (American Book Company) is the book for primary grades in the "Authorized Physiology Series." It teaches what the laws now require in regard to alcoholic beverages and tobacco, with frequent iteration, and states briefly the general rules of health and the structure of the body. Physiology and anatomy, however, are treated in the first two books of the series merely as aids "to enable the pupil to comprehend the topic which is the real object of study, viz., the laws of health and the nature of alcoholic drinks and other narcotics, and their effects upon the human system." The volume is written in simple language, it is clearly printed, and is made attractive with many illustrations. The series is indorsed by the Woman's Christian Temperance Union.

The Open Court Company, Chicago, publishes by special license of the author, *Three Lectures on the Science of Language and its Place in General Education*, which were delivered at the Oxford University Extension Meeting of 1889, by Prof. *F. Max Müller*. In the first lecture the author finds a mark of distinction between man and animals in the use of language transmitted from generation to generation, and shows how the enormous vocabulary of the English language has grown up from a comparatively small number of primitive roots. In the second lecture these roots are shown to correspond with distinct concepts in the mind of man, of which animals have none; and the lesson taught by the science of language—which is shown to have a practical value—is expounded. In the third lecture the author maintains that language—which is the key to thought—affords a surer test of race affiliations than physical characteristics can, and insists upon his theory of the Asiatic origin of the Aryans as against the Scandinavian theory of some modern students. To the three lectures are added an essay, entitled My Predecessors, in which Prof. Müller disclaims originality for his idea of the identity of thought and language, and strives to show that it has been taught by the nominalists and other philosophers in the past. (Price, 75 cents.)

A group of stories from Norse Mythology has been published by *Mary E. Litchfield*, under the title *The Nine Worlds* (Ginn, 60 cents). The style of the book is intended to be simple enough for children, but not too simple for adults. The author says: "I have written the story of the gods as it has formed itself in my mind after much reading and thinking. Whatever is coarse or unpoetic in the old stories has been left out, and much has been added from my own imagination." She has taken various liberties with the ancient legends, such as putting certain prophecies into the mouth of Odin, because he is represented as knowing the future, supplying connecting links in the history, and giving added prominence to certain characters.

PUBLICATIONS RECEIVED.

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Ballard, Julia P. Among the Moths and Butterflies. New York: G. P. Putnam's Sons. Pp. 237. $1.50.

Bardeen, Charles Russell. Home Exercise for Health and Cure. Syracuse, N. Y.: C. W. Bardeen. Pp. 91.

Carter, J. M. G., Waukegan. Report of the Committee (Illinois State Medical Society) on Practice of Medicine. Pp. 10.

Chadwick, John W. Evolution and Social Reform: the Theological Method. Boston: James H. West. Pp. 10. 10 cents.

Cook, Albert S. Sir Philip Sidney. The Defense of Poetry, with Introduction and Notes. Boston: Ginn & Co. Pp. 143. 90 cents.

De Costa, B. F. The Pre-Columbian Discovery of America by the Northmen. Albany, N. Y.: Joel Munson's Sons. Pp. 196. $3.

Fairman, Dr. Charles E. The Fungi of Western New York. Rochester, N. Y.: Academy of Sciences. Pp. 14, with Plates.

Fernow, B. E., Washington, D. C. Report of the Chief of the Forestry Division for 1890. Pp. 60.

Fiske, John. Civil Government in the United States. Boston and New York: Houghton, Mifflin & Co. Pp. 360. $1.

Georgia, Department of Agriculture. Crop Report. August 1, 1890. Pp. 13.

Gould, George M., M. D. The Relation of Eye-strain to General Medicine. Pp. 21. Philadelphia: The Medical News.

Griswold, W. M., Cambridge, Mass. Descriptive List of Novels and Tales dealing with American Country Life.

Hale, Edwin M., M. D. Tachycardia Vaso-motoria. Pp. 17.

Harkness, Albert. An Easy Method for Beginners in Latin. New York, etc.: American Book Company. Pp. 348.

Hinds, J. I. D. What? How? Why? Whither? Nashville, Tenn.: Cumberland Presbyterian Publishing House. Pp. 54, with Blanks. 25 cents.

Holyoake, George Jacob. What would follow the Effacement of Christianity. Buffalo, N. Y.: H. L. Green. Pp. 15. 10 cents.

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James, William. The Principles of Psychology. New York: Henry Holt & Co. 2 volumes. Pp. 689 and 704.

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Leffmann, Henry, and Beam, William. Progressive Exercises in Practical Chemistry. Philadelphia: P. Blakiston, Son & Co. Pp. 104.

Macfarlane, James. An American Geological Railway Guide. Second edition. New York: D. Appleton & Co. Pp. 426. $2.50.

Marcou, J. Belknap. Bibliography of North American Paleontology for 1886. Washington: Smithsonian Institution. Pp. 56.

Mays, Thomas J., M. D., Philadelphia. Address in Hygiene. Pp. 13.

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Mills, Wesley. A Text-book of Comparative Physiology. New York: D. Appleton & Co. Pp. 636. $3.

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Nadaillac, Marquis de. Prehistoric America. New York: G. P. Putnam's Sons. Pp. 566. $2.25.

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Northam, Henry C. A Manual of Civil Government. Missouri Edition. Syracuse, N. Y.: C. W. Bardeen. Pp. 151.

Oliver, Charles A., M. D., Philadelphia. Analysis of Symptoms of General Paresis. Pp. 6.—Description of Tests for Color-blindness. Pp. 8.

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Preble, Henry, and Parker, Charles P. Handbook of Latin Writing. Boston: Ginn & Co. Pp. 109. 55 cents.

Pringle, Allen, Selby, Ontario. Foul Brood among Bees. Pp. 30.

Prudden, T. Mitchell, M. D. Dust and its Dangers. New York: G. P. Putnam's Sons. Pp. 111. 75 cents.

Randall-Diehl, Mrs. Anna. A Practical Delsarte Primer. Syracuse, N. Y.: C. W. Bardeen. Pp. 66.

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Wagner Free Institute of Science, Philadelphia. Transactions. Vol. III. Pp. 200.

Weeden, William B. Economic and Social History of New England, 1620–1789. Boston and New York: Houghton, Mifflin & Co. 2 volumes. Pp. 964.

Wiechmann, Ferdinand G. Sugar Analysis. New York: John Wiley & Sons. Pp. 187. $2.50.

POPULAR MISCELLANY.

Folk-Lore.—The American Folk-Lore Society will hold its annual meeting in New York city, on November 28th and 29th, these dates being the Friday and Saturday following Thanksgiving-day. The sessions will be held at Columbia College, Madison Avenue and Forty-ninth Street. The Philadelphia meeting held last year was signalized by large attendance and the formation of a local chapter of the national society which has held meetings monthly throughout the winter. Folk-lore has been defined as the collective sum of the knowledge, beliefs, stories, customs, manners, dialects, expressions, and usages of a community which are peculiar to itself, and which, taken together, constitute its individuality when compared with other communities. Folk-lore has been placed on a scientific basis as a recognized department of anthropology. A growing interest in its study is manifested especially since it is regarded as an important adjunct to history, often indeed preserving the only records of a race. The officers of the society for 1890 are as follows: President, Dr. Daniel G. Brinton, Philadelphia, Pa.; Council, Hubert Howe Bancroft, San Francisco, Cal.; Franz Boas, Worcester, Mass.; H. Carrington Bolton, New York, N. Y.; Thomas Frederick Crane, Ithaca, N. Y.; Alice Fletcher, Nez Percés Agency, Idaho; Victor Guilloû, Philadelphia, Pa.; Horatio Hale, Clinton, Ont.; Mary Hemenway, Boston, Mass.; Henry W. Henshaw, Washington, D. C.; Thomas Wentworth Higginson, Cambridge, Mass.; William Preston Johnson, New Orleans, La.; Charles G. Leland, London, England; Otis T. Mason, Washington, D. C.; Secretary, W. W. Newell, Cambridge, Mass.; Treasurer, Henry Phillips, Jr., Philadelphia, Pa. The society publishes a quarterly, entitled The Journal of American Folk-Lore, a handsome octavo, bearing the imprint of Houghton, Mifflin & Co. It is sent free to members. The membership fee is three dollars per annum. The society numbers at present about three hundred and fifty, but an increase in membership, especially in New York and Brooklyn, is desirable. Persons wishing to join the society, or to receive the circular announcing the meeting, should address Dr. H. Carrington Bolton, University Club, New York city.

Distribution of North American Plants.—A sitting of the Biological Section of the American Association was given, by appointment from the Toronto meeting, to the discussion of the geographical distribution of North American plants. The first paper was by Mr. Sereno Watson, on the relation of the Mexican flora to that of the United States. It showed that the Mexican flora is more nearly related to the flora of our Eastern than of our Western border. Prof. J. M. Coulter, in a paper on the Distribution of the Umbelliferæ, said that the study of the subject was difficult, because of the imperfect definition of the genera. The order and species were, however, better defined. The order is essentially one of the north temperate zone; and, so far as North America is concerned, it is an order of the United States. Of the fifty-three genera of the United States twenty-five are also found in Asia. The chief home of the order is in the region of the Sierra Nevada, where fifty-four per cent of our known species are found. Special areas exist in the Great Basin and in Arkansas. The Distribution of the Hepaticæ was described in a paper by Prof. L. M. Underwood, who spoke of the defective condition of our knowledge of the subject. The order is represented by about 2,500 species, most of which are found in the south tropical regions, in the moist forest areas, and along the borders of waters. Prof. B. D. Halsted traced the origin of some American weeds and the manner of their spread over the country, and described the lines along which they have run and are still advancing. The distribution of North American grasses was described by W. J. Beal, who showed the areas marked by special varieties, the lines along which they are extending, and the modifications that follow the change from wild to cultivated land. The *Cornaceæ*, or order of dogwoods, was the subject of a second paper by Dr. J. M. Coulter. It includes, he said, three genera, which find their most congenial home in Mexico and along the Mexican border. They are found farthest north in the Pacific States. The last paper was by Prof. N. L. Britton, who presented the general subject. Temperature, he said, is the most important factor in distribution, and it depends on elevation and latitude. The most abundant flora is the temperate, which extends along various lines to a considerable distance north. The northern floras are characteristic, but also extend south, chiefly along the mountain-chains. Tracing the paleontological evidences on the subject, the author thought that all plant-life north of the fortieth degree of latitude was probably destroyed during the Glacial period. Below that line existed the circumboreal flora, which subsequently followed the retreating ice north. Some suppose that it thus simply returned to its former habitat. The sub-tropical flora of the Tertiary age must have been almost destroyed during the Ice age, yet it has certain boreal characters. There is a marked correspondence between the boreal and tropical flora of America and Europe, which can hardly be explained by migration. Probably similar environment has given rise to similar lines of development, starting from types having more or less in common. The discussion was so satisfactory to the section that a committee was appointed to consider upon the selection of a subject for a similar series of papers at the next meeting.

Insect Aid for our Orange-growers.—Bulletin No. 21 of the Division of Entomology is entitled Report of a Trip to Australia, made under Direction of the Entomologist to investigate the Natural Enemies of the Fluted Scale. Mr. Koebele, the divisional agent who makes the report, acting under instructions from Prof. Riley, and aided by funds through the State Department, and the courtesy of Hon. Frank McCoffin, Commissioner-General to the Melbourne Exposition of 1888–'89, sailed for Australia in August, 1888, where he remained until March of the succeeding year, collecting and making shipments to California of the parasites of the fluted scale. No little difficulty was experienced in finding sufficiently large colonies of the scale to obtain enough specimens infested with parasites, as the latter, aided by other enemies, have reduced and nearly exterminated the *scerya* in Australia. A large number of a small dipterous parasite were shipped, but, as this is a slow breeder, its work has been eclipsed by a small lady-bird which was afterward discovered and comprised the major part of the later shipments. This lady-bird, called the *Vedalia*, has done such good service that the fluted scale is now practically overcome in California, and orange-growers have again taken heart. The report deals besides with injurious insects observed during Mr. Koebele's stay in the country, among the most notable being the orange and olive scales, and a scale known as *Monophlœbus*, remarkable for its immense size, being larger than any heretofore known. All of these scales are highly injurious, and figures accompany the descriptions of them, besides which is mentioned and figured a snout beetle imported from the Mediterranean region, which is very injurious to the young shoots and leaves of the olive. In addition to the dipterous parasite (*Lestophonus*) and the *Vedalia* before mentioned, as forming the bulk of the shipments for California, there were also included a number of other beneficial predatory insects. These were several small coccinellids of the genera *Scymnus*, *Coccinella*, *Rodolia*, and *Leis*, all of which are more or less important as scale-destroyers. As a rival of the last there were brought over about a hundred larvæ of a noctuid moth (*Thalpochares cocciphaga*), which is a most efficient scale-eater in its larva state and promises to become a valuable adjunct to our other introduced scale enemies. The work, however, of the lady-bird (*Vedalia cardinalis*) has been so very effective that the other species have been kept in the background and probably driven to the wall. Within a year after its introduction the *Vedalia* had practically exterminated the *Icerya* and given a renewed impulse to orange culture in California. Great credit is due to Prof. Riley for the scientific work that has secured this important result.

The Tarantula.—The tarantula, says A. J. Field, in Knowledge, is one of the largest but not the most venomous species of spiders found in Europe. It is one of the *Lycosidæ*, or wolf-spiders, is about three quarters of an inch long, and is covered all over its body with an olive, dusky-brown down. During the summer months, while creeping among the corn, it bites people employed in the fields, but the bite, though painful, is seldom dangerous. According to Dr. Zangrilli, the part bitten becomes deadened soon afterward, and in a few hours there are slight convulsive shiverings, cramps of the muscles, and spasm of the throat, followed by vomiting and a three days' fever. Recovery generally follows after a copious perspiration, but in one case there was tetanus and death on the fourth day. The tarantula is common in Spain, southern France, and Italy, where it occurs in great numbers in Apulia round the town of Taranto. It has been found in Asia and in northern Africa. It lives in dry places, partly overgrown with grass and fully exposed to the sun, in an underground passage which it digs for itself and lines with its web. These passages are round, sometimes an inch in diameter, and extend to the depth of a foot or more below the surface. This spider is very quick in its movements, and eager in the pursuit of its prey. It has been known to allow itself to be carried into the air by a large fly that it has attacked rather than relinquish its hold. The female tarantula lays from nine hundred to a thousand eggs in a season, and shows considerable maternal care. She has never been known to abandon her offspring until they are able to take care of themselves. She hatches two broods in the year, in spring and autumn, and has been known to hatch three. The eggs are deposited after they are hatched within a bag or cocoon almost as thick as paper, which the mother makes for them, and then fastens to the end of her body. When the young ones are excluded from their shells within the cocoon they remain in confinement until the female, instinctively knowing their maturity, bites open the bag and sets them free. The young of web-making spiders, after leaving the egg, immediately commence weaving, but the young tarantulas (leading a vagrant life and having no web), being incapable of protecting themselves, remain for about a fortnight with the mother. This formerly gave rise to a belief that they derived their nourishment from her body.

Poisonous Spiders.—It does not seem to be generally known that spiders secrete a poison of a very active nature, the effects of which are similar to those produced by snake poisons. The bite of the common house-spider is quickly fatal to flies and other insects on which it preys; when a fly is bitten by a spider its whole body seems seized by violent convulsive twitchings, and death generally occurs after a few minutes. The spider's poison issues from a sac and duct at the base of its mandibles; it closely resembles the venomous matter secreted by scorpions, and is a transparent fluid, containing traces of formic acid and albumin. The spider is provided with a most effective apparatus for injecting its poison, consisting of modified mandibles called falces, the last joint of which has a hard curved fang, with a fissure near the point. The muscles used in closing the mandibles also press upon the poison-gland, causing the poison to be expelled through the fissure into the wound, and thence into the circulation of the victim. The most venomous spider known is a little fellow confined to New Zealand, called by the native inhabitants "Katipo," its bite not infrequently causing chronic illness or death. Mr. W. H. Wright describes the case of a person bitten by the katipo on the shoulder. "The part bitten rapidly became swollen and looked like a large nettle-rash wheal. About an hour afterward the patient, could hardly walk; the respiration and circulation were both affected, followed by prolonged muscular prostration. The patient, however, recovered in two or three days."

African Jumpers.—Dr. Bennett, of Griqualand, writes an account of a peculiar nervous affection which is met with among the Griquas and other natives and individuals of mixed descent living in Griqualand. He suggests that perhaps the affection is similar to that prevalent among the French Canadians and known by the name of "Jumpers," which was described by Dr. G. M. Beard in The Popular Science Monthly for December, 1880. Dr. Bennett says: "The affection is entirely confined to the male sex, and I have never seen or heard of a case in the female. The victims of this strange form of neurosis go through the most extraordinary and grotesque antics on the slightest provocation. A whistle, a touch, a shout—anything, in fact, sudden and unexpected—will 'set them going.' Some will stiffen their limbs, make hideous grimaces, and waltz about as if they had no joints in their body. Others will jump wildly about like dancing dervishes, imitating the particular sound that had acted as an exciting cause. Some, again, will make use of the most obscene expressions on a transient impulse, correcting themselves immediately afterward and expressing their regret for having used such language; while others, on the spur of the moment, will do anything they are told to do. If they should happen to have a piece of tobacco in their hand and one should suddenly shout 'Throw it away!' they will do so at once, running away for a short distance and trembling all over their body. I remember one case in particular. It was that of a young man, a mason by trade. He had been handed a piece of tobacco, and the person who handed it to him shouted out suddenly, 'Throw it away; it is a snake!' He first danced about wildly for a short time, and then ran away as fast as he was able; but he had not gone far when he fell down in a 'fit,' and it was some time before he recovered." As to the probable cause of this affection, Dr. Bennett is disposed to ascribe it to the indiscriminate intermingling of the blood of different racial types and the intermarriage of those standing in close relationship to one another.

Poisonous Mussels.—An unusual case of poisoning recently happened in Seapoint, County Dublin, Ireland, and was described in the London Lancet. A lady, her five children, and a servant partook of a meal of stewed mussels obtained from a small sheet of water to which the sea had access, but which received fresh water and some sewage. In about twenty minutes after the ingestion of the mussels some of the children complained of a prickly sensation in their hands; graver symptoms rapidly supervened, and in less than an hour one of the children died, the mother and three other children succumbing within two hours after eating the mussels. One of the children and the maid (the latter had eaten but few of the mussels) suffered very much, but recovered. The chief symptoms were vomiting, difficulty in breathing, swelling of the face, want of co-ordination in movement, and spasms, principally in the arms. It was thought that the poisonous nature of the mussels was due to their feeding on sewage. Some mussels obtained from the same place were found to have abnormally large livers and a much more brittle shell than common. Leucomaine, an alkaloid poison, was found in the vomited matter.

Resources of Nyassa-Land.—Nyassa-land, which extends from the southern shores of Tanganyika Lake to the Zambezi River and from the Congo free state to the Shire River, one of the centers of the African slave trade, has been brought into prominent attention by the activity of missionary enterprise in and around it. Its suitableness for British colonization has been discussed in the British Association by Captain F. D. Lugard. It is touched by the most eligible route into Central Africa, which lies by the water-way of the Zambezi, Shire, and Nyassa to Tanganyika. The carrying trade to the missions is already sufficient to pay dividends to a small company. Then there grows up rapidly around each mission station a desire for some of the rudimentary necessities of civilization; and these, together with salt, a chronic savage want, and metal wire and beads for personal adornment, are essentially the pioneering elements, and indeed constitute the money of the country, for which the natives are willing not only to bring their produce, but to work by the week or month. The country has to offer in return supplies of mineral wealth, the variety and amount of which are as yet unknown, but certainly exist. They include gold, copper, iron, asbestus, and coal, and are probably sufficient to pay the initial cost of exportation. Other products are ivory, which is destined to decrease; coffee, tea, cloves, cinchona bark, and India rubber, which have as yet hardly reached the experimental stage, but promise to be profitable when developed. Several minor products, not sufficient in themselves to sustain trade, will help it along as supplements to the staples. The beans of the miranguti tree are used by the natives for food, and furnish a fat suitable for illuminating purposes and for soap-making. The bark supplies a capital mahogany dye, which is believed to have preservative qualities. Enormous herds of cattle are accompanied by plants endowed with tanning properties. There are oil-seeds and dyes, several fiber plants, and in the lowlands several kinds of timber trees of some value, although this article is worth less than some of the others. Many kinds of imported trees, however, thrive excellently. As to salubrity, the Shire Highlands have proved by the test of many years to be well adapted to the conditions of European life. But the malarious coast country has to be passed through, and the first requisite to settlement is therefore a means of rapid conveyance from the coast, with better facilities for accommodation and comfort.

The Tradition of Mount Kasbek.—The ascent of Mount Kasbek, of the Caucasus system, was accomplished by the Russian topographer Pastuchoff on the 29th of July, 1889. From the summit, 16,246 feet above the sea, a view was had that "surpasses description." The peak itself is concealed from view from below by the projection of a spur which appears from the foot of the mountain to be the highest point. The rim of a crater, the south side of which has been broken in, occupies a part of the summit. The explorers came down in a violent rain-storm which flooded the valleys and did much damage to the corn and destroyed some of the natives' huts. This was regarded by the people as a penalty for the sacrilege which the party had committed in intruding upon the holy summit. According to an Ossete tradition, when God had determined to send Jesus Christ down to the earth he could find no place except this peak which had not been defiled by the sinful feet of men. He therefore placed the child in this spot in a golden cradle, and by the side of it a dove, and a sheep with golden horns. The dove was to rock the cradle and coo, and the sheep to amuse the child with its bleating. The animals were fed from a pile of wheat which the Lord provided for them. When Jesus had grown up he came down to the earth, performed his divine acts, and went back to heaven; but he left the cradle, the dove, and the sheep on the mountain as memorials of his abode there. The dove is still rocking the cradle, and the bleating of the sheep can sometimes be plainly heard in the evening; and they are still fed on the wheat, which has never failed. The belief prevails among the Ossetes that God will never permit any one to go up to the top of the Kasbek. Many have tried it without succeeding. Some have been made blind, others have been cast into the gorges, and others have been buried under the snow. Now the Russian has gone up and taken away the golden cradle; for which God manifested his anger in a terrible storm.

Gas Cooking-Stoves.—Gas cooking-apparatus have the advantages over coal stoves that they produce no dust or cinders, and are more cleanly in every way. The oven can be heated to a desired temperature in only a few minutes after the gas is lighted, while the degree of heat can be regulated according to the nature of the articles to be cooked by simply adjusting the valves that control the supply of gas and the ventilation. While gas may be somewhat more expensive than coal, by careful regulation of the supply and attention to turning off the gas the instant it is out of use, the difference can be reduced till it is hardly perceptible. Gas-ovens may be heated by burning the gas directly within them, or by applying the flame to the walls. In the former case the products of combustion are present with the meat, with effects on taste and odor that are not always agreeable. In the other case the meat is not distinguishable from a joint roasted before the open fire. The stove should be supplied with an escape flue to the open air. Boilers—for the kitchen only—may be attached to the larger stoves and heated from below by atmospheric burners. The average consumption of gas in a range for a family of ten persons is estimated to be twenty feet an hour for six hours a day.

Geology as an Educational Instrument.—Prof. A. H. Green spoke in the Geological Section of the British Association over which he presided, on the value of geology as an educational instrument, and certain attendant risks that need to be guarded against. Geologists, he said, are in continual danger of becoming loose reasoners. They are too ready to accept conclusions upon insufficient evidence. The reason is not far to seek. The imperfection of the geological record is a phrase as true as it is hackneyed. Then, how many of the geological facts gathered from observation admit of diverse explanations—as in the theories of the nature of *Eozoon canadense!* That, after all, is only one of the countless uncertainties that crowd the whole subject of invertebrate palæontology. In what a feeble light have we constantly to grope when we attempt the naming of fossil conchifers, for instance! It is from data scrappy to the last degree, or from facts capable of being interpreted in more than one way, or from determinations shrouded in mist and obscurity, that geologists have in a large number of cases to draw conclusions. Inferences based on such incomplete and shaking foundations must necessarily be largely hypothetical. That that is the character of a great portion of the conclusions of geology all are ready enough to allow. The living day by day face to face with approximation and conjecture must tend to breed an indifference to accuracy and certainty, and to abate that caution and wholesome suspicion which make the wary reasoner look to his foundations and refuse to sanction superstructures not firmly and securely based. The author did not infer that geology could find no place in the educational curriculum. There are many ways of neutralizing whatever there may be potentially hurtful in the use of geology for educational ends. One way to make a geologist is not to teach him any geology at all to begin with—to send him first into a laboratory, give him a good long spell of observations and measurements requiring the minutest accuracy, and so saturate his mind with the conception of exactness that nothing shall ever afterward drive it out. The uncertainties with which the road of the geologist is strewn have an immense educational value if we are on our guard against taking them for anything better than they really are. A man who is ever dealing with geological evidence and geological conclusions, and has learned to estimate these at their real value, will carry with him, when he comes to handle the complex problems of morals, politics, and religion, the wariness with which his geological experience has imbued him. There are immense advantages which the science may claim as an educational instrument. In its power of cultivating keenness of eye it is unrivaled, for it demands both microscopic accuracy and comprehensive vision. Its calls upon the chastened imagination are no less urgent, for imagination alone is competent to devise a scheme that shall link together the mass of isolated observations which field-work supplies; and its pursuit is inseparably bound up with a love of nature, and the healthy tone which that love brings alike to body and mind. Geology should be taught in schools also for its relation to geography and to the history of nations and the distribution and migrations of peoples.

Transitions of Fauna in the Mississippi Delta.—In a paper read in the American Association, in his absence, by W J McGee, Mr. L. C. Johnson said that he had made use of the Nita crevasse of 1890 of the Mississippi River to illustrate the manner in which the abrupt changes of fresh-water to salt-water fauna, and *vice versa*, of which frequent evidences appear in the delta, have been brought about. The crevasse was the most extensive that has been formed for many years; and through it flowed a volume of fresh water sufficient to transform the previously brackish lakes and saline bays on the left of the river into fresh-water lakes and estuaries. One of the prominent results of the flood was the destruction of the salt-water fauna and the substitution of a fresh-water and mud-loving fauna over an immense area. The oyster-beds along the coast, which were the basis of an important industry, were injured, and in many cases destroyed. The sea-fishing region was also ruined, and the pickerel and other characteristic fishes of the Mississippi may now be taken where four months ago only salt-water forms were found. Hitherto the geologist employed in the lower Mississippi region has been puzzled to account for the sudden transitions of fauna; but here we have a case where one of them was effected in a single week, over as wide an extent as all of those which have so embarrassed the student.

The Mediterranean.—The presidential address in the Geographical Section of the British Association, by Sir R. Lambert Playfair, was on the Mediterranean Sea. Its shores, the author said, include about three million square miles of the richest country on the earth's surface. They are a well-defined region of many parts, all intimately connected by geographical character, geology, flora, fauna, and the physiognomy of the people. To the general statement there are two exceptions—Palestine and the Sahara. The sea, a mere gulf, now bridged by steam, rather unites than separates the two shores, modifying their climate and forming a junction between three continents. The Atlas range is a mere continuation of the south of Europe. It is a long strip of mountain land, about two hundred miles broad, covered with splendid forests, fertile valleys, and in some places arid steppes, stretching eastward from the ocean which bears its name. In the east of the range the flora and fauna do not essentially differ from those of Italy; in the west they resemble those of Spain. Of the three thousand plants found in Algeria, the greater number are natives of southern Europe, and less than a hundred are peculiar to the Sahara. There are mammalia, fish, reptiles, and insects common to both sides of the sea. Some of the larger animals, such as the lion, panther, jackal, etc., have disappeared before civilization in Europe, but linger through Mohammedan barbarism in Africa. There is abundant evidence of the former existence of these and other large mammals of tropical Africa in France, Germany, and Greece. The original fauna of Africa, of which the lemur is the distinctive type, is still preserved in Madagascar, which once formed part of Africa. The trout is found in all the snow-fed rivers that fall into the sea, but not in Palestine south of the Lebanon, or in Egypt, or the Sahara. The fresh-water salmonoid is a European type often found in the Atlas. There are newts and tailed batrachians in every country round the sea, again excepting Palestine, Egypt, and the Sahara.

Economic Plants of Colombia.—A report of the British Foreign Office names a large variety of important economical plants as successfully cultivated in Colombia. The principal crop is maize; next to it is sugar-cane, which is most used for making sugar, while large quantities of it are employed for making aguardiente and rum in the hot country, and chicha, another drink, in the cold country. The plant ripens in one year in the hot country, and in a year and a half in the cold country. Cacao is largely raised in the hot country on the slopes of the mountains, on newly disforested land, at an elevation of from one thousand to three thousand five hundred feet. It is the most paying crop in the country when once established, but very difficult and expensive to take care of in the earlier years of its growth. For planting the upland rice, the ground is "prepared" by turning cattle into the field after the first rains to tread up the ground and destroy the grasses. They are again turned in and driven round, after the seed has been sown, to tread it into the ground, after which no further attention is paid to the crop till the harvest. The potato forms the chief food of the country. It is very productive, and is cultivated in two principal varieties—the *criollas*, which are red-skinned, and yellow or orange-colored inside, and the ordinary white potato. It also grows wild in the mountains. The largest and best crops are raised on savannas on the mountain-sides at heights of more than nine thousand feet. The production has greatly decreased since the potato disease attacked the crops in 1865. Tobacco is grown on a large scale in four districts and on a small scale all over the country. Other cultivated plants are plantains, which form an important food and are very productive; manioc, which is used as a vegetable or made into bread; vegetable ivory palm; *Carlodovica palmata*, from which the Panama hats are made; coca; coffee, the production of which is increasing and which is taking the place of cinchona bark as the chief article of export; American aloe, which grows wild everywhere and is valuable for its fibers; and cinchona. Pineapples, oranges, mangoes, cherimozas, and other native fruits grow very abundantly and spontaneously, and are so cheap that, except in the immediate neighborhood of a market, few people take the trouble to pick them.

The Start of a Bird's Flight.—The mechanism of the starting of a bird's flight, as studied by instantaneous photography, is thus described by Professor Marey: "When the bird is not yet in motion, the air which is struck by its wings presents, in the first instance, a resistance due to inertia, then enters into motion, and flies below the wing without furnishing to it any support. When the bird is at full speed, on the contrary, its wing is supported each moment upon new columns of air, each one of which offers to it the initial resistance due to its inertia. The sum of these resistances presents to the wing a much firmer basis. One might compare a flying bird to a pedestrian who makes great efforts to walk on a shifting sand, and who, in proportion as he advances, finds a soil by degrees firmer, so that he progresses more swiftly and with less fatigue. The increase of the resistance of the air diminishes the expenditure of labor; the strokes of the bird's wing become, in fact, less frequent and less extended. In calm air, a sea-gull which has reached its swiftest expends scarcely the fifth of the labor which it had to put forth at the beginning of its flight. The bird which flies against the wind finds itself in still more favorable conditions, since the masses of air, continually renewing themselves, bring under his wings their resistance of inertia. It is, then, the start which forms the most laborious phase of the flight. It has long been observed that birds employ all kinds of artifices in order to acquire speed prior to flapping their wings: some run on the ground before darting into the air, or dart rapidly in the direction they wish to take in flying; others let themselves fall from a height with extended wings, and glide in the air with accelerated speed before flapping their wings; all turn their bill to the wind at the moment of starting."

Origin of Warts on Forest Trees.—The formation of abnormal growths—knots or warts—on forest trees, which are very common on some species, is thus accounted for by Robert Cowpar in Science Gossip: "They are not due to insects, fungus, or accident, but are perfectly natural. Neither may they be taken as indications of health or disease, nor are they in any way attributable to any particular soil or situation. . . . In the barks of our forest trees are contained a multitude of latent buds which are developed and grow under certain favorable conditions. Some trees possess this property in a remarkable degree, and often, when the other parts are killed down by frost in severe winters, the property of pushing out these latent buds into growth preserves the life of the plant. These buds, having once begun to grow, adhere to the woody layer at their base, and push out their points through the bark toward the light. The buds then unfold and develop leaves, which elaborate the sap carried up the small shoot. Once elaborated, it descends by the bark, when it reaches the base or inner bark. Here it is arrested, so to speak, and deposited between the outside and inner layer of bark, as can be learned on examining specimens on trees in the woods almost anywhere."

Value of Phenological Observations.—Phenological observations of plants, or observations of the time of the first appearance in the year of the several stages of growth, have long been recognized as useful in the study of climates. A phenological observer may in five years determine approximative means for judging of the succession of each of the phases of vegetation. When we have ascertained the mean time of the occurrence of the principal changes for five years, as, for instance, when the first apple blossoms open in the immediate vicinity of the station, or the first fields of barley are cut, we are then able to judge how the station comports itself relatively to any other station of which the phenological position is fixed; and how each point of a region comports itself relatively to the principal point —whether it is colder or warmer. This is determined by the stage of vegetation which the same plants have reached here and there. The method is really more exact than that of establishing hundreds of thermometers and pluviometers at as many different places —aside from the trouble and expense of keeping up the observations of so many instruments. Phenology goes on without expense, while meteorology is costly. We are able, every year and every week in the year, to compare observations of vegetation with means that have been established, and assure ourselves whether the vegetation at our station is normal or in advance. Phenology is a kind of thermometry that can also be used to test thermometrical observations and correct erroneous conclusions from them. The plant is a sort of registering thermometer. It, in fact, shows us the present condition, as the thermometer does, and likewise all the conditions of the past time, immediately summed up in a final result, while the thermometer simply gives us the daily oscillations and leaves us to make the summing up. Phenological observations, with figures founded on comparisons, have the advantage of raising the thought of relation in the mind, of representing something tangible to it.

Ancient Fireplaces on the Ohio.—The ancient fireplaces at Blue Banks and other places on the Ohio River near Portsmouth are described by Mr. T. H. Lewis as being of three different classes. Those on the lower levels only show a burned streak of clay from five to eight feet in diameter, with but a slight concavity, on which are found ashes, charcoal, burned stones, and bones, with an occasional fragment of pottery, composed of broken stone and clay. Many of them, at the level of twenty feet from the surface, where they are most numerous, are from one to three feet deep, and are lined with flat stones. The clay outside of the stones bears evidence of intense heat. In some instances they are nearly filled with ashes and charcoal. The pottery within them is composed of shell and clay. At a higher level, the fireplaces, while not so numerous, are more interesting, because more or less of fire relics are obtained from them. They are only slightly concave, and mixed with the ashes are stones broken by the action of fire, bones of various kinds, arrow-heads, drills, stone and hematite celts, stone pipes, perforated stones called shuttles, and much broken pottery. These places seem to have been occupied at different times, and also by different tribes or nations. The first occupants used stone in the manufacture of their pottery. They were succeeded by others who used shells, and these in their turn gave way to people using stone. The latter seem to have occupied the ground for only a brief period, and then to have been displaced by others using shell. In the adjoining field, however, both kinds of pottery are found intermingled. It is Mr. Lewis's opinion that the people of these fireplaces antedated the residence of the mound-builders in their neighborhood by many centuries, because the works of that race, themselves very ancient, are found on the surface above them. The fireplaces occur at various levels, from near the top of the bank to thirty feet below. At one point they were visible at seventeen different levels. They are exposed to view by the caving off of the banks at high water. A somewhat similar series of fireplaces or ovens was described in the American Association by Prof. Putnam as observed on the banks of the Little Miami River.

Cold Waves.—According to Prof. T. Russell's explanation of the subject, in the American Association, the term cold wave is employed when a fall of temperature occurs in twenty-four hours of 20° or more over an area of at least 50,000 square miles, and the temperature in any part of the area descends to 36°. According to this definition, there were in the United States, between 1880 and 1890, 691 cold waves. In the great cold wave of January 17, 1882, the twenty-degree fall line included an area of 1,101,000 square miles, and the ten-degree fall line an area of 2,929,000 square miles. There have been in ten years six cold waves in which the area of the twenty-degree fall was more than a million square miles. The cold waves seem always to occur over the country covered on the preceding day by an area of low barometric pressure, or the southeast of the country covered by an area of high pressure. Where both occur, the cold waves attain their greatest extent. Only a few cases are recorded in which low pressure areas have not been followed by a fall of temperature at their centers. In twelve instances within ten years there were rises in temperature instead of falls. On the other hand, cold waves do not occur without the presence of an area of high or low pressure. The extent of the cold wave is dependent on the extent of the area of low pressure and the area of high pressure on the day preceding it. The shapes and relative positions of areas of high and low pressure are various, and are described and classified in the author's paper.

The Forest.—In a paper read at the American Association Prof. B. E. Fernow said that the forest is both a material resource and a cultural condition. While it may and does form the object of individual activity, it also can by its location or position become an element influencing climate, soil, and waterflow. The climatic influence of forest areas is as yet not generally proved, although conditionally accepted, but the influence of forest areas upon the waterflow, and with it upon soil conditions and upon winds, is generally recognized. As a material resource the forest is exhaustible, but restorable within limit. The virgin forest must be reduced to get the agricultural ground that is needed, but when the requirement for food is satisfied it is desirable to treat the forest in such a manner as to secure continued reproduction. This gives rise to forest management and forestry as an industry. Reproduction of the natural forest is inferior in quality and quantity to that which can be produced by national forest management. After mentioning some special considerations and economical peculiarities pertaining to forest growth and forestry which may influence the relation of the state toward them, the author went on to say that, so far as the forest represents a material resource simply, the position of the state toward it need not differ from that which it takes toward other industries and resources, except in so far as the peculiar conditions call for special exercise of the protective and persuasive or educational functions of the state. Being a restorable resource, restriction of private enterprise in regard to it can not be demanded. The restrictive and providential action of the state is only necessary in reference to those forest areas whose existence and proper condition influence other cultural conditions. Since restriction of private rights is always impracticable and unsatisfactory, and compensation of damages difficult to adjust, commercial or state ownership of mountain forests is advocated. The ameliorative function of the state is called into play for the reforestation of the large treeless areas where private energy is powerless to accomplish the desired result.

NOTES.

It appears to be the belief of some that as man in the savage state has, for the most part, been largely, if not wholly, carnivorous, he will, with the progress of civilization, become entirely vegetarian or use only the products of animals, as eggs and milk, with vegetable food. A vegetable diet has been found very successful in treating kidney troubles and indigestion. In point of economy it is an enormous saving, not only in actual cost to the consumer, but also in land; as of two equal portions of ground, one raising a cereal and the other beef or mutton, the part devoted to the cereal will support ten times as many men as the beef or mutton portion.

In a letter on compressed tea, which recently appeared in the Kew Bulletin, Colonel Alexander Montcrief says that one of the chief advantages claimed for this form of tea is that, being subjected to heavy hydraulic pressure, all the cells are broken, and the constituents of the leaf more completely and easily extracted by the boiling water, thus effecting a considerable saving in the quantity required for a given amount of the beverage. There is also a gain in its greater compactness and portability.

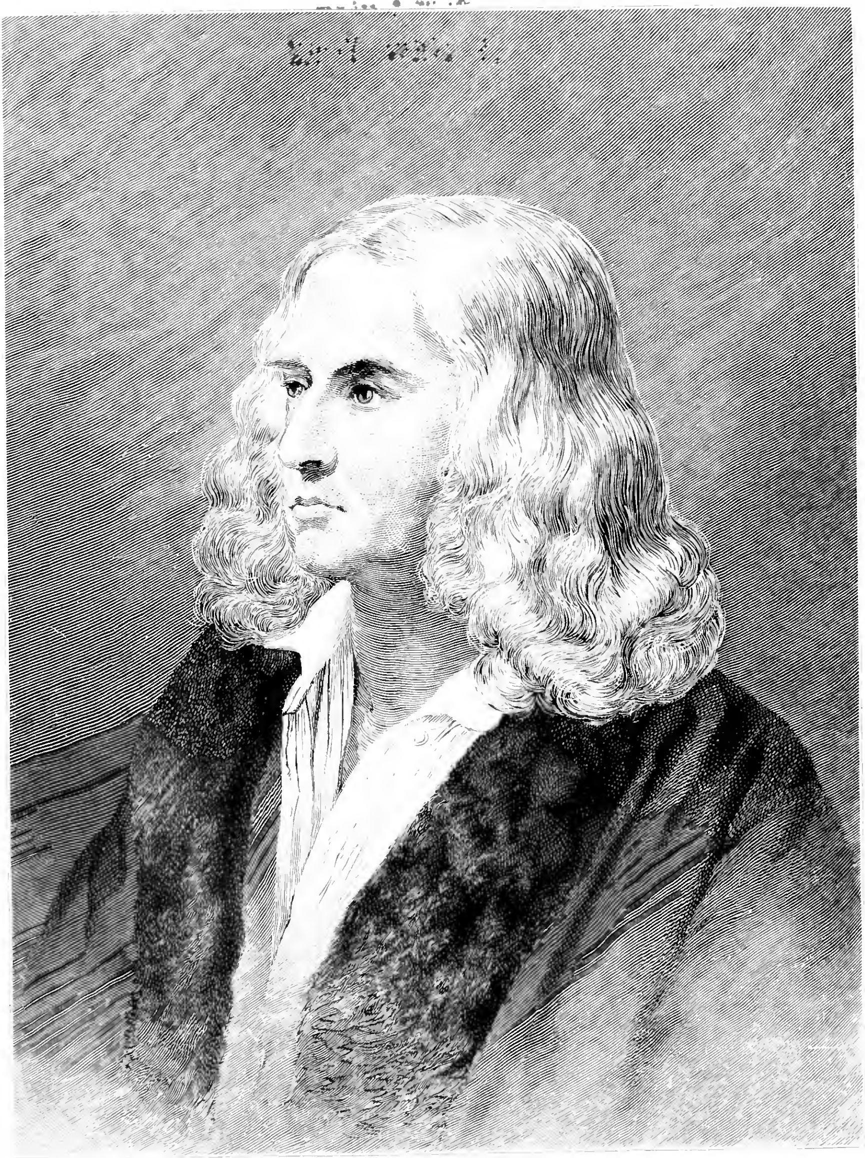
It is said that Iceland is gradually becoming depopulated, owing to the constant emigration of its people to the shores of Canada and the United States. These emigrants send back such favorable accounts of their new home that others quickly follow. It is estimated that twenty thousand natives, nearly one quarter of the whole population, have left the country in the last year. The emigrants are chiefly from the northern and eastern districts, where labor is only carried on under great difficulties, and recent bad harvests have caused much suffering.

The largest plant-fossil in Europe is exhibited at the Berlin Berg-Akademie. It was discovered in 1884 in the coal-mines of Piesberg, and sent to Berlin by the magistrate of Osnabrück. With great difficulty the mass was cut out of the earth in which it was imbedded and carted away. The fossil is a piece of a gigantic ancestor of the ordinary lycopodium of the present day, known as *Sigillaria*. It consists of a trunk about one yard in diameter, which divides at the bottom into several fork-like, strong roots. The surface of the trunk looks like wood, and shows a graining in the form of long ridges. The bark is still traceable in places in charred-looking remains. The entire fossil, with the exception of the charred pieces of bark, consists of argillite.

Daniel J. Rankin, ex-acting consul at Mozambique and a recent traveler in Africa, read a paper at the January meeting of the Royal Geographical Society on the Chinde River and Zambezi Delta. He points out the importance of cheap and rapid means of communication with civilized markets to the vast tract of country comprised by the Zambezi basin, whose only outlet is through the delta; calls attention to the difficulties attending navigation of the Quillimane and Kongoni ports, the ones now chiefly used; and shows the superiority of the Chinde River in its depth of water and comparative clearness and constancy of channel as a road for import and export.

Sir Morell Mackenzie has recently written upon The Effect of Tobacco-smoking on the Voice. He tells us that most of the leading actors suffer from a relaxed condition of the upper throat, brought on, he believes, entirely by smoking; but actresses are rarely affected in that way. He has noticed the same thing in public speakers and clergymen. He says that for a delicate throat the usual smoke-laden atmosphere of a common railway smoking-car is even worse than the actual use of tobacco. The Oriental hookah is, in Dr. Mackenzie's opinion, the least harmful apparatus, as the smoke, passing through water is cooled before entering the system; and the cigarette, so popular nowadays, is the most harmful.

The people of the island of Sangir keep time by the aid of an hour glass, formed by arranging two bottles neck to neck. The sand runs out in half an hour, when the bottles are reversed. Close by them a line is stretched on which hang twelve sticks marked with notches from one to twelve, with a hooked stick which is placed between the hour last struck and the next one. One of these *djaga* keeps the time for each village, for which purpose the hours are sounded on a gong by the keeper.



ADELBERT VON CHAMISSO.

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THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

I. EARLY STEPS IN IRON-MAKING.

By WILLIAM F. DURFEE, Engineer.

TO all familiar with the iron and steel industries of this country it will be manifest that the story of their technological development can not possibly be told exhaustively in a magazine article, whose length is scarcely sufficient for an adequate description of a single one of the larger mechanisms employed in working iron or steel at the present time. Therefore, all that will be attempted in these papers is such a description of the beginning, growth, and present state of the technology of these vulcanian industries as will enable non-professional readers to obtain an intelligent idea of the more important improvements in machinery and methods that have contributed to a progress which, by successive steps, albeit oftentimes short, slow, and uncertain, has brought these industries safely through the manifold perils of three hundred years to their present wonderful expansion.*

All authorities agree in the opinion that iron was unknown to the aboriginal inhabitants of America. Tools, weapons, ornaments, and culinary vessels made of copper were occasionally found in their possession, but nothing of iron.

* In the preparation of these papers I am indebted to James M. Swank, Vice-President and General Manager of the American Iron and Steel Association, for the opportunity to consult the library of the Association; and for extracts from his very valuable contribution, Iron in all Ages, to the history of the manufacture of iron and steel. I am also under obligation to E. C. Potter, Second Vice-President of the Illinois Steel Company, for engravings and photographs of parts of the very extensive works of that company. John Thomas, Superintendent of the Thomas Iron Company, Hokendauqua, Pennsylvania, has kindly furnished me with some interesting facts relative to the first anthracite blast-furnace; and from J.

The first mention of the existence of iron-ore on this continent was by Thomas Harriot, "the geographer" of the second expedition to Virginia. This expedition effected a settlement on Roanoke Island, and Harriot in his history of the colony says: "In two places of the countrey specially, one about foure score and the other six score miles from the fort or place where wee dwelt, wee founde neere the water side the ground to be rockie, which, by the triall of a minerall man was founde to hold iron richly. It is founde in manie places of the countrey else. I know nothing to the contrarie but that it maie bee allowed for a good marchantable commoditie, considering there the small charge for the labour and feeding of men; the infinite store of wood; the want of wood and the deerenesse thereof in England; and the necessity of balasting of shippes." Nothing seems to have come of this discovery; and the colony, being menaced by the Indians, became discouraged and returned to England in 1586.

We next read of American iron-ore in the history of the colony which located at Jamestown, Virginia, in 1607. We are told that "on the 10th of April, 1608, the company's ship sailed from Jamestown, loaded with iron ore, sassafras, cedar posts, and walnut boards." Seventeen tons of iron made from this ore in England was sold to the East India Company for £4 per ton. This was without doubt the first sale of iron made from American ores. An attempt was made in the years 1620 to 1622 to erect iron-works on Falling Creek, a branch of the James River, about sixty-six miles above Jamestown, but on the 10th of March, 1622, the buildings were burned by the Indians and 347 persons were killed; thus ending in fire and blood the first attempt to make iron on a manufacturing scale on this continent.

We have no account of the actual form of the furnaces or other apparatus, nor any description of the methods of smelting employed in the earliest iron-works of this country, but from the evidence accessible we are quite safe in assuming that the early American metallurgists were in no great degree wiser than their European instructors; and, when we consider the difficulties of every kind that must have surrounded all attempts to manufacture iron in a new country, it seems highly probable that our early iron masters would have adopted the simplest and most inexpensive methods known to be capable of accomplishing the desired

Vaughan Merrick and James Moore, of Philadelphia, I have received information in regard to the early use of the Nasmyth steam hammer in the United States. I am also indebted to Oliver Williams, Esq., President of the Catasauqua Manufacturing Company, of Catasauqua, Pennsylvania, for information relative to the manufacture of anthracite iron at that place. I also acknowledge with pleasure the kind offices of W. H. Wahl, Ph. D., Secretary of the Franklin Institute, and James Gayley, Esq., Superintendent of Furnaces at the Edgar Thomson Steel Works.

result, and, as fuel and ore were abundant, it is not likely that economy would be much studied in their use.

The simplest process known for obtaining iron from its ore can be carried out in an ordinary blacksmith's fire by throwing crushed ore upon the ignited fuel, covering it with coal, and, after urging the fire with bellows for a considerable time, there will be found in the bottom of the fire an irregular mass of forgeable metal. Some form of this process is still employed by many savage and semi-civilized people; and this was doubtless the method used by the "mineral man" in testing the ores of iron discovered by the Roanoke colonists in 1585.

In Fig. 1 is shown a modification of this process, practiced by the iron-workers of Persia and adjacent countries, who have

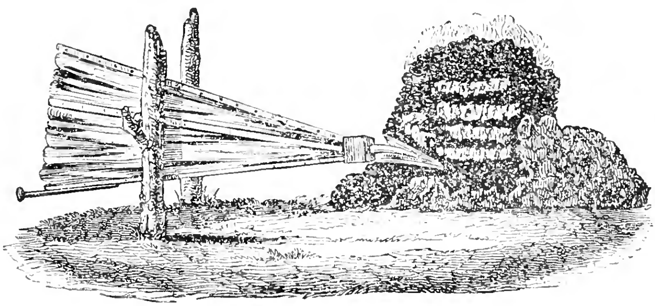

Fig. 1.—Persian Method of Smelting Iron.

manufactured both iron and steel by this simple and inexpensive method (as measured by their standards of the value of time, labor, and material), from the days of Tubal-Cain to the present time, and have fabricated therefrom cutting tools and weapons of unsurpassed excellence. The keenness of edge, wonderful temper, and marvelous elasticity of the swords of Damascus have had a world-wide fame for thousands of years. George Thompson, the distinguished English orator and philanthropist, stated that "when in Calcutta, he saw a man throw in the air a handful of floss silk, which a Hindoo cut in pieces with his saber. Many of the swords and daggers made in central and western Asia two thousand years ago were as remarkable for their elaborate finish and exquisite ornamentation as for their more practical qualities.

The process, illustrated by Fig. 1, was substantially as follows: A basin-shaped hole, six to twelve inches in depth and twelve to twenty-four inches in diameter, was first made in the earth; this cavity was then lined with moistened charcoal dust, which was well rammed to make it as dense as possible; the hearth thus formed was then filled with charcoal, on which was placed a layer of crushed ore, and over this alternate layers of fuel and ore until the heap was of the desired height; the outside of the mass of charcoal and ore was then incased in a covering of rough stones laid in a mortar of clay and sand, or, in some cases, it was merely plastered over with a thick layer of such mortar; care was always taken to have a hole near the bottom, just above the edge of the hearth, for the insertion of a tube of baked clay to serve as a *tuyère*, and a second hole at the top for the escape of smoke and gases. Fire was then introduced at the *tuyère* and the bellows connected; a gentle blast being used until all the moisture in the ore and the covering of the heap was driven off. As soon as this was accomplished, the blast was increased and the heat thereby augmented. At the end of several hours a mass of metallic iron, weighing twenty or thirty pounds, was found in the bottom of the hearth, from which it was removed by tongs and forged by sledge-hammers into the desired shape, several reheatings being required. The iron obtained was not usually over twenty per cent of that in the ore, and only the richest ores were used.

The first attempts to smelt iron-ore were probably made in open, or perhaps partially inclosed, fires, in which the operation was conducted without the stimulus of a blast; but the slow and very irregular burning of the fuel during calms, as compared with its more rapid and effective combustion when urged by a high wind, must have soon suggested the desirability of a regular and manageable method of supplying the primitive furnaces with a current of air, and we find that the use of some contrivance for this purpose is of great antiquity.

Bellows are known to have been used by the Egyptians over three thousand years ago. They consisted of a pair of leather bags (which were nearly spherical when inflated), to each of which was attached a tube for the discharge of the air.* The operator stood with a foot on each of these bags, and pressed them alternately by throwing his weight from one foot to the other. In the top of each bag was a round hole, which could be closed by the foot of the workman, and a cord held in each hand enabled him to distend and inflate either bag as he compressed the other. His feet served as valves to prevent the escape of air from the holes, and compelled it to pass through the discharge-pipe into the fire.

Piston bellows were known in Egypt at least two thousand years ago, and compressed air was used for various purposes other than blowing fires. The kind of bellows shown in Fig. 1 was known and used by the Greeks and Romans at a very early period, and the bellows of our kitchens are of equal antiquity. Bellows

* Perhaps the expression "a pair of bellows," which in the days of "open hearth" practice in our older kitchens was quite common, had its origin in an equivalent Egyptian colloquialism.

constructed as shown in Figs. 3 and 15, were invented in Germany in the latter part of the sixteenth century; the exact date, as well as the inventor's name, is uncertain. Bellows working on the principle of those used in accordions and concertinas have also been known for many centuries. An engraving, showing such bellows in use blowing a furnace, is given in the great work of Agricola,* who also illustated rotary fan-blowers; but these evidently did not propel the air centrifugally, as does the modern fan-blower, but pushed the air forward, very much as a revolving paddle-wheel pushes water.

Another very curious apparatus for blowing furnaces and smiths' fires is called a *trompe*. It consists of a vertical pipe, usually made of wood, of a length suited to the fall of water. Near the top of this pipe there are pierced a number of comparatively small lateral openings which incline downward in their passage through the thickness of the sides of the pipe, whose lower end enters the closed top of a barrel or other air-tight vessel, from which proceeds a tube to convey the air to the furnace or forge. This contrivance operates as follows: The descending column of water in the pipe draws in air through the lateral openings near its top, and this air is carried down by the water and separates from it in the interior of the barrel and then passes to the forge by the discharge-pipe, the water escaping through a hole at or near the bottom of the barrel. Percy,† speaking of this very simple blowing apparatus, says, "It is said that it was invented in Italy in 1640." But it must have originated at a much earlier date, as Branca ‡ gives three applications of it, illustrated by engravings, and it is very probable that this highly ingenious method of employing the fall of water to compress air was known and used hundreds of years before the time of Branca.

The early American forges and furnaces were blown either by the ordinary leather bellows (Fig. 1), or by wooden cylinders called "blowing-tubs," or by the *trompe* just described, and there are still to be found in use a few examples of each of these primitive methods of "raising the wind." In Fig. 2 we have an illustration of a pair of "blowing-tubs" such as Overman # describes as "the best form of wooden blast-machine." The figure shows a vertical section through the axes of the upright "blowing-tubs," *a a*, and the "wind-chest," *b*, placed immediately above them. Air enters the tubs from beneath and is pumped by the pistons *d d*, with the aid of the "clack-valves" shown in the figure, into the wind-chest. The pressure of the air in the wind-chest is determined by the weight *h* suspended at the lower end

* De Re Metallica, Basilæ, 1546.

† Metallurgy, Iron and Steel, London, 1864.

‡ Le Machine, Roma, 1629.

The Manufacture of Iron, Philadelphia, 1850.

of the rod attached to the piston *g*, which rises and falls as the volume of air beneath it varies in accordance with the demands of the furnace or the slight irregularities of supply. The air was conveyed to the furnace through a metal pipe, *c*, connected with the wooden bottom of the wind-chest by a flanged elbow. Blowing-tubs of a square cross-section with corresponding pis-

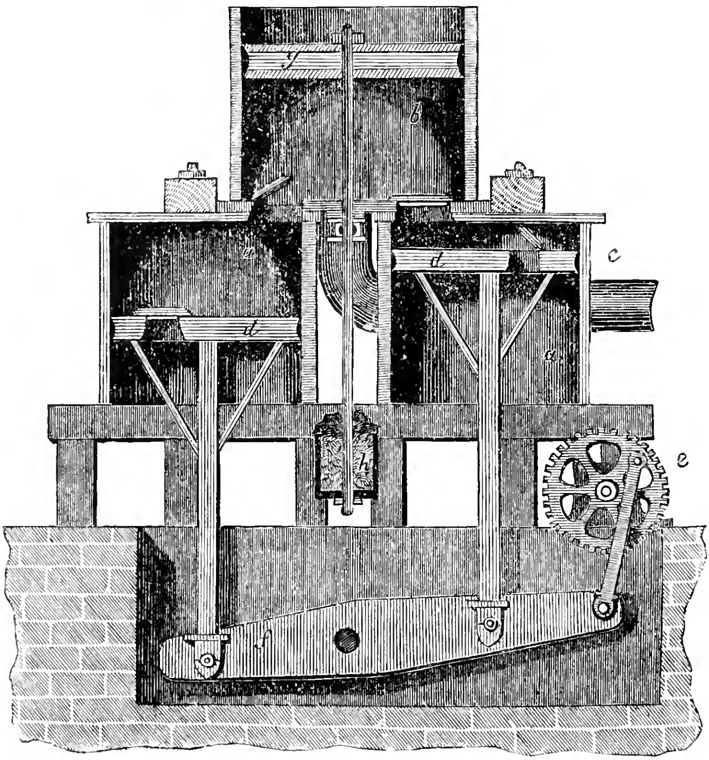

Fig. 2.—A Pair of Blowing-Tubs.

tons have been used with success, and as late as 1873 three such machines were in use in Detroit for furnishing blast to a large cupola; and, notwithstanding the primitive construction of this blowing apparatus, the melting was quite as satisfactory and economical as the best of the present day.*

Having now described the various forms of apparatus for blowing furnaces and forges in use at the beginning of the seventeenth century, we will again turn our attention to the progress of the manufacture of iron in America. The first iron-works built in this country that are entitled to be called successful

* The average record of the cupola blown by these square wooden "blowing-tubs" was eleven pounds of metal melted by one pound of fuel. Very few cupolas now in use do as well, and by far the greater number are not more than half as economical.—W. F. D.

were erected in the Province of Massachusetts Bay, in what is now the town of Saugus, a suburb of the city of Lynn, about ten miles northeast of Boston. Their owners, "The Company of Undertakers for the Iron-works," were granted a number of special privileges, among which was the monopoly of the manufacture for twenty-one years. The works appear to have been commenced late in the year 1643 or in the beginning of 1644, and were nearly completed in 1645, as on the 14th day of May in that year the General Court passed a "Resolve," declaring that "y[e] iron-works is very successful (both in y[e] richness of y[e] ore and y[e] goodness of y[e] iron)," and that "y[e] furnace is built, with that which belongeth to it, . . . and some tuns of sowe iron cast . . . in readiness for y[e] forge." On the 14th of October of that year the General Court granted still further privileges on the condition "that the inhabitants of this jurisdiction be furnished with barr iron of all sorts for their use, not exceeding twentye pounds per tunn," and that the land already granted be used "for the building and seting up of six forges, or furnaces, and not bloomaries onely," and the company was confirmed in the right to the free use of all materials "for making or moulding any manner of gunnes, potts, and all other cast-iron ware."

On the 6th of May, 1646, Richard Leader, the general agent of the company, purchased "some of the country's gunnes to melt over at the foundery." This statement seems to justify the belief that there may have been a reverberatory furnace in this "foundery," as such furnaces were well known in Europe at that date, and castings of all sorts were made from metal melted in them; but it is certain that, at the same period, castings were frequently made from iron taken direct from the blast-furnace, and we know that scrap cast iron can be melted in a blast-furnace without difficulty. The cupola furnace, for remelting "pig iron" and scrap cast iron, was not invented until 1790, and, consequently, we are sure that it was not employed in the "foundery" at Lynn in 1646. Hence it is evident that the "gunnes" purchased must have been remelted in the "blast-furnace," or in a reverberatory furnace, although we have no decisive evidence of the employment of the latter type of furnace.

It is certain that at Lynn, in the Province of Massachusetts Bay, was cast, in the year 1645, the first piece of hollow ware made in America—"a small iron pot capable of containing about one quart." * This pioneer of all American-made castings was in existence in 1844, but recent efforts † to ascertain its whereabouts have been unsuccessful. The works at Lynn appear to have been very prosperous for a number of years; but after a time they

* Lewis's History of Lynn, 1844. † By C. H. J. Woodbury, Esq., of Lynn.

became unpopular, owing to the flowage of lands by their dam, and the great destruction of timber for fuel.

The Rev. William Hubbard, writing in 1677,* says they were "strenuously carried on for some time, but at length, instead of drawing out bars of iron for the country's use, there was hammered out nothing but contentions and lawsuits." Just about this time Samuel Butler was writing his great poem in which he makes Hudibras say:

> Alas! what perils do environ
> The man who meddles with cold iron!—

a reflection which has been sadly appropriate in the case of too many American iron-works.

After the establishment of this first successful "furnace" and "foundery" at Lynn, works for the manufacture of iron were erected in other parts of New England, and thence the business spread into New York, New Jersey, Pennsylvania, and Maryland. During the "French War" (1755) there were a number of furnaces in operation at which "cannon, bombs, and bullets" were made in great quantity, and many of these iron-works furnished similar supplies to the Continental army during the Revolution.

It is a matter of profound regret that no drawings of the early iron-works erected in this country have been preserved; and we are therefore compelled to form our ideas of their construction from such meager verbal descriptions as are given by writers of the time, combined with illustrations of furnaces and processes for the manufacture of iron known to have been used at or near the same period in Europe. The iron-works at Lynn seem to have embraced a "blast-furnace," a "foundry," and a forge. The product of the furnace was in part made into "sowe iron," and the remainder used in "y^e^ foundery," for the manufacture of hollow ware and other castings. In "y^e^ forge," the sow iron † was converted into "all sorts of barr iron." The blast-furnaces in use in Germany at that time were from twenty to twenty-five feet high, and had boshes, and openings at several heights for the purpose of tapping out the cinder. In the Philosophical Transactions for 1676, Henry Powle, describing the furnaces then in operation in the Forest of Dean, in Gloucestershire, England, says: "The blast-furnaces are about twenty-four feet square on the outside, nearly thirty feet high, and eight or ten feet wide at the boshes. Behind the furnace are placed two huge pair of bellows, whose noses meet at a little hole near the bottom.

* The Present State of New England, 1677.

† "Sowe iron" was an elongated mass of cast iron, tapering at each end, and having a triangular cross-section; it was often twenty feet in length, and weighed from twelve to fifteen hundred pounds. It was made by running the fluid iron from the furnace into a trench in sand, where it solidified.

These are compressed together by certain buttons, placed on the axis of a very large wheel, which is turn'd about by water in the manner of an overshot mill. As soon as these buttons are slid off, the bellows are raised again by the counter-poise of weights, whereby they are made to play alternately, the one giving its blast all the time the other is rising."

Fig. 3 * is a vertical section of a blast-furnace, such as had been used for some years in Sweden prior to 1734; and it may be regarded as representative of the construction of furnace that had been employed in Germany, France, and England for the previous hundred years, and in all probability for a much longer period. The reader will readily perceive that the bellows (made of wood) were operated by what Henry Powle, above quoted, described as "certain buttons"; and in fact the construction and size of the furnace illustrated did not differ greatly from that seen by Powle. This Swedish furnace was fifteen feet square outside, and twenty-nine feet high; its internal diameter at the top, D D, was four feet, and at the widest part six feet. The "boshes," or diminishing part of the furnace, O O, were made of a mixture of fire-clay and crushed quartz; the inner walls, M M, were of sandstone laid in regular courses, while the outer walls, G G, were made of any convenient coarse, rough stone laid in lime mortar; the space, F F, between the inner and outer walls, was filled with cinder, small stones, and other similar material. The hearth, C, was about two feet square. The top of the furnace was surmounted by a parapet, H, of rough-hewn logs. Comparing the construction of this furnace with the earlier practice, Swedenborg says:

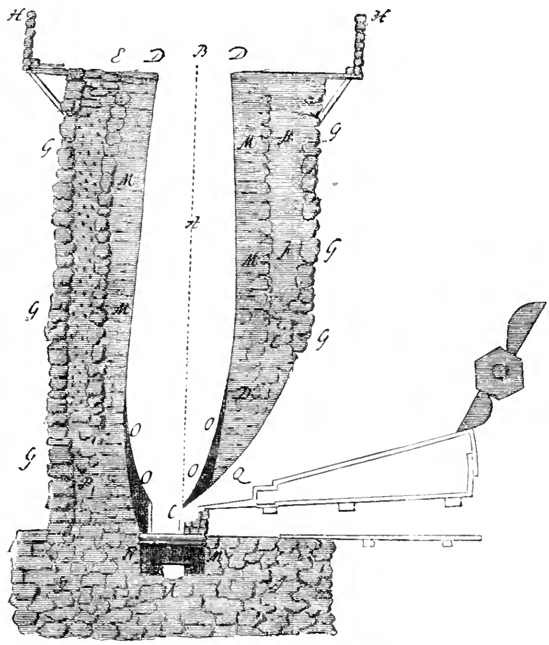

Fig. 3.—Vertical Section of a Blast-Furnace of the Seventeenth and Eighteenth Centuries.

* From De Ferro, by Emanuel Swedenborg, 1734.

"Formerly furnaces were constructed much simpler, and no specific or exact proportions were observed; and it was not considered necessary that the walls should have any fixed dimensions, either as to thickness or height; but (according to Agricola, who was the first to describe them) the whole structure was rude,

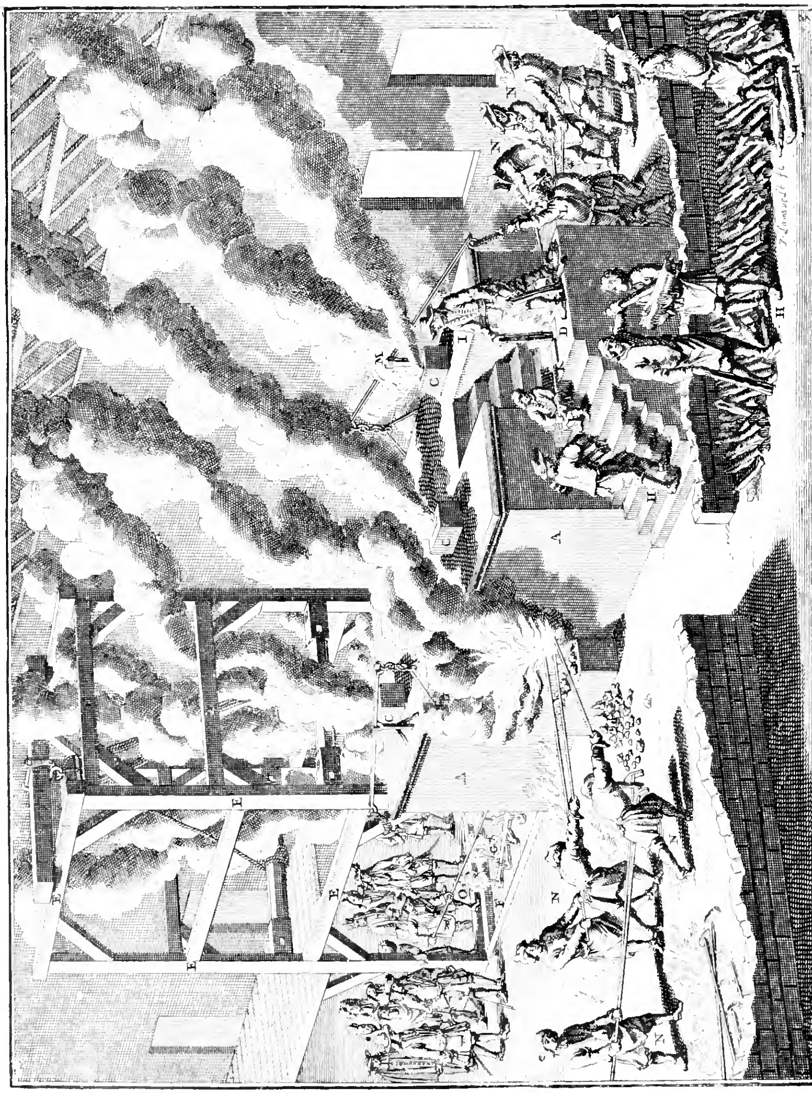

Fig. 4.—A Reverberatory Furnace. (1647.)

loose, and imperfect, their daily product of iron was small, and they consumed a very large quantity of charcoal; but afterward, when it became evident that regularity in smelting insured excellence of product, and at the same time the realization of greater profit, then more perfect plans were made, and higher furnaces, having greater capacity and more solid walls, were constructed."

The reverberatory furnace had been employed in Europe from the earliest times for the melting of brass and other metals; and for heating them dry wood was the usual fuel. Benvenuto Cellini (about 1547) erected such a furnace for melting the bronze for his statue of Perseus; and he expressly states that he commenced the melting with "pine wood, which, because of the oiliness of the resinous matter that oozes from the pine tree, and that my furnace was admirably well made, burned at such a rate, that I was continually obliged to run to and fro, which greatly fatigued me"; and, after describing various troubles in getting the metal melted, he finally completes that operation by the use of "a load of young oak, which had been above a year in drying."

From a French work on the construction of artillery * we take Fig. 4, which is a very spirited illustration of a reverberatory furnace at the moment when the metal is being tapped into the molds. In this figure A is the furnace; B, the furnace-doors, which are made of iron; C, chimneys of the furnace; D, fire-hole; E, frame of carpentry above the pit, to which is attached the pulleys and other tackle which serve to lower the molds into the pit and remove the castings made; F, pit (made in the earth), in which the molds are placed; G, "runners" with "gates" for the metal; H, workmen who split the wood and carry it to the furnace; I, workman who throws the wood into the fire: the wood falls upon a grate which is at the bottom of the fire-box, three feet or more below the part of the furnace containing the metal; K, cover, or paddle of iron, for closing the mouth of the fire-box; L, workmen who raise the furnace-doors by means of a lever; M, lever for raising furnace-doors; N, workmen who stir the melted metal with poles of wood, and who remove the slag and refuse metal with tools called "rabbles"; O, the master founder, with the tapping-bar, opening the hole by which the metal is discharged into the "runners"; around him stand a group of interested visitors. After this description we are told that "the furnace at Douay contains sixty thousand pounds of metal." This would not be regarded as a small furnace even now.

As illustrating how the metal was taken from the early blast-furnaces for the making of "sowe iron" and castings of various kinds, we reproduce † Figs. 5 and 6. In Fig. 5 workmen, numbered 1 and 2, are seen making an open mold of triangular cross-section in the floor of the "foundry," in which is to be cast a sow,

* Mémoires d'Artillerie, 1647.

† From Recueil de Planches, sur les Sciences, les Arts Libéraux, et les Arts Méchaniques avec leur explications. A Paris, 1765.

and others (3 and 4) are removing, by means of levers and rollers, the sow last made. The wooden bellows which blow the furnace are shown at R, R, R. The furnace illustrated appears to have been constructed with unusual care, its walls having been

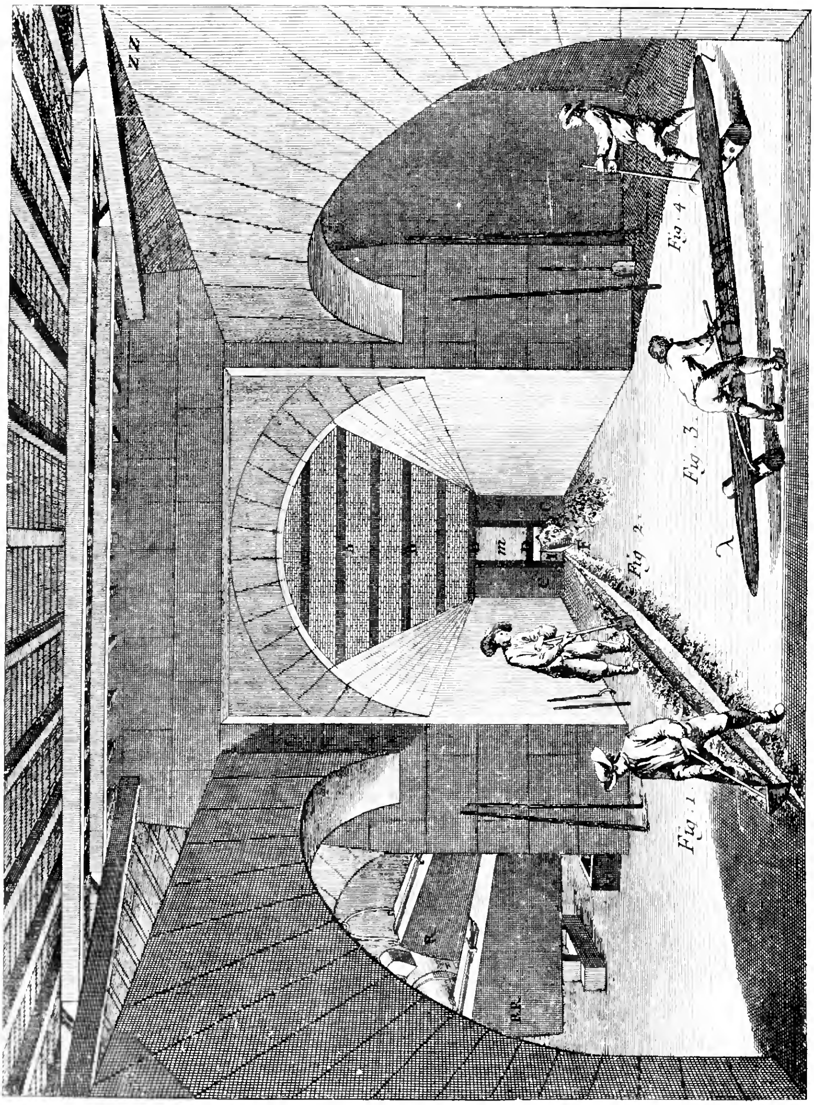

Fig. 5.—Preparing to cast a Sow.

built of dressed stone laid in regular courses, strengthened at the corners by massive rampant arched buttresses, one of which is marked Z, Z. At B, B, B, are iron bearers that support the masonry of the furnace above the arch; C, C, are side stones of the hearth; D is the "tymp"; F, the "dam"; I, the "tap-hole."

In Fig. 6 we have a view of the interior of an ancient "foundry," in which the metal was taken direct from the blast-furnace and used for the making of castings. In this engraving a workman (1) is taking the metal from the hearth of the furnace over the dam F, with a ladle. Another workman (3) is "pouring" the

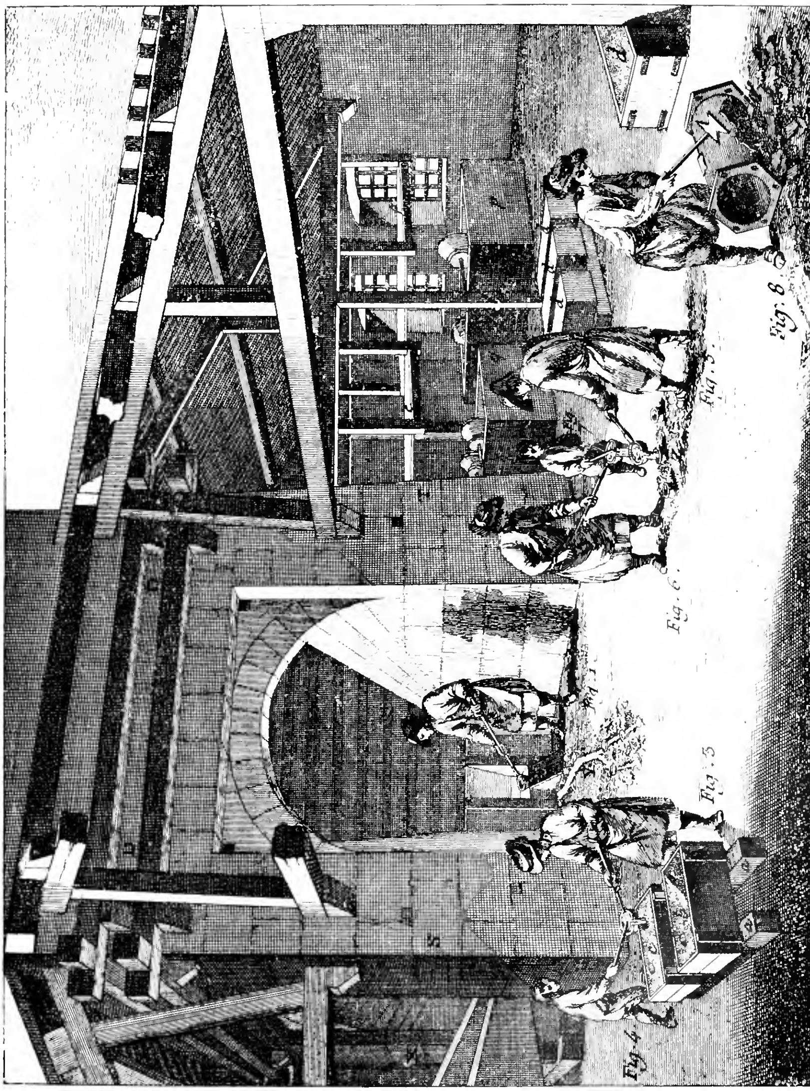

Fig. 6.—Interior of an Ancient Foundry.

mold *c*, with metal from a hand-ladle; while a boy (4) skims the metal and prevents slag and other floating impurities from escaping with the metal from the ladle; close at hand is another mold, *b*, ready for pouring. At 5 is a man pouring metal from a hand-ladle into the "gate," Z, of a mold that is buried in the floor of the "foundry," while a second man (6) keeps him supplied with metal from another ladle which is skimmed by a boy (7). At 8 is a man cleaning a cast-iron pipe. Pipes made at this period were rarely over three feet in length, and were provided with polygonal flanges at each end for fastening them together with bolts. Pipes two inches in diameter had oval flanges and two bolts; three-inch pipes had triangular flanges; eight-inch pipes were square-flanged; while pipes of twelve and eighteen inches in diameter had flanges of six and eight sides respectively, the number of bolts always equaling the number of angles in the flanges.

It is not at all certain when the first castings were made from remelted sow, or other form of crude cast iron; but the crucible has been used for remelting cast iron since a very remote period, and is largely employed in China for that purpose at the present

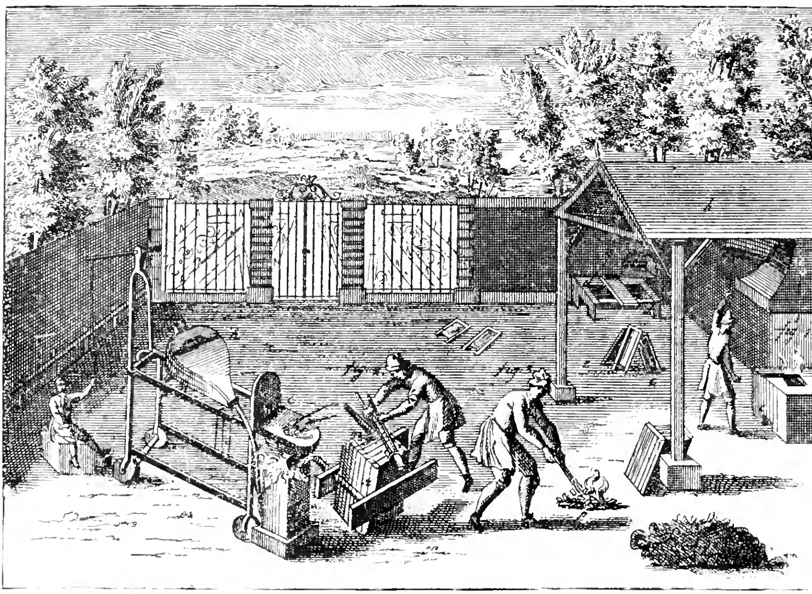

Fig. 7.—The Process of Casting Crucible-melted Iron.

day, and the culinary utensils made in that country are remarkable for their thinness. As illustrating the making of castings from crucible-melted iron, we extract Fig. 7, from Réaumur's* work. In this plate "*b* is a shed, under which is placed a furnace *c*, such as is ordinarily found in the shops of the makers of small castings. This furnace was blown by bellows, held but one crucible, and was quite similar in construction to many furnaces in use at the present day; *d d* is a box for holding the molding-

* L'art de convertir le fer forgé en Acier, et L'art d'adoucir le fer fondu. Par Monsieur de Réaumur, de l'Académie Royale des Sciences. Paris, 1722.

sand; *e e* are molds being dried. At the left is seen a small portable furnace on wheels, to which blast is supplied by the bellows *h*, of a forge. When this is used as a forge, the bellows *h* are re-arranged so as to blow through an opening at the top. In the figure, 2 is a workman filling a mold with fluid metal which has been melted in the furnace. At *m* are seen the screw-clamps that confine the three molds *n*. Near the middle of the picture are two parts of a mold separated; at the right, in the foreground, is a pile of charcoal, and at *q* is a furnace (similar to a baker's oven) for drying the cores for the molds."

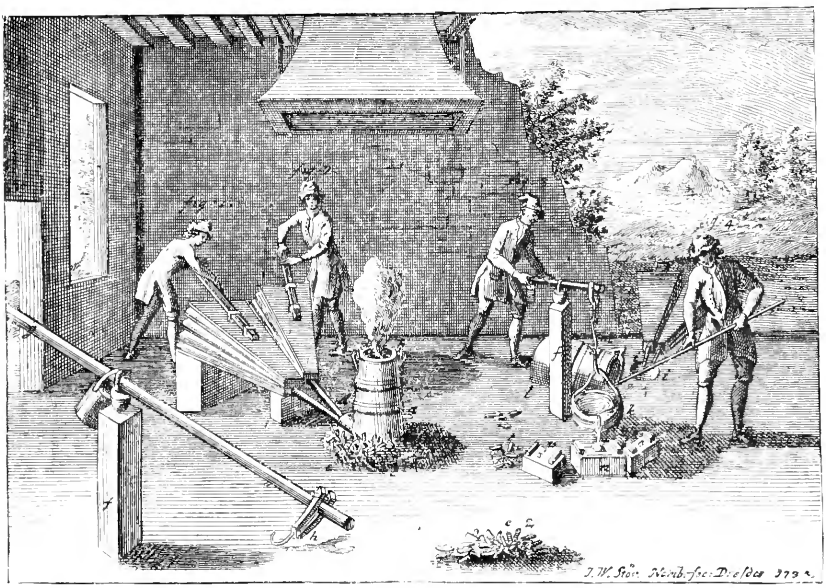

FIG. 8.—MELTING IRON FOR CASTING IN SMALL FURNACES.

In Fig. 8 (also taken from Réaumur's treatise) "is shown two common furnaces in which the iron to be melted is thrown among the charcoal without being placed by itself in a crucible; one of these furnaces is represented as erected, and actually melting the iron; while the other is dismounted, and the melted iron is being poured into molds. "The workmen (1 and 2) operate the bellows; *a b* is the upper part of the furnace, whose base is buried in charcoal dust; *b* is the opening into which is thrown the charcoal and pieces of iron; *c c*, the powdered charcoal which surrounds the base of the furnace; *d* is the *tuyère* which receives the noses of the bellows; *e* is a heap of charcoal; *e* 2 is a pile of fragments of cast iron; *f* is a post which supports the lever *g*, by means of which the ladle which forms the bottom of the furnace is easily raised." The workmen (3 and 4) are occupied in pouring into molds the iron which has been melted in the second furnace, which is exactly like that already described; 3 is manœuvring the lever, to one end of which the ladle containing the melted iron is suspended; 4 holds the handle and tips the ladle, thus regulating the pouring of the metal; *i i*, the hole from which the ladle *k*, forming the base of the second furnace, was taken for pouring; *l*, the upper part of the furnace removed; *n*, mold in which the iron is being poured."

Réaumur also describes a third apparatus for melting cast iron, which consists of a furnace of similar form to that just described, but without the removable ladle bottom. This furnace was supported on "trunnions" by a carriage mounted on wheels; at a proper height above the bottom was a "tap-hole," and on the opposite side an opening, or *tuyère*, for the nose of the bellows. The iron to be melted was (as in the last furnace) mixed directly with the fuel, and when it became fluid accumulated in the bottom of the furnace; as soon as all the iron was melted, the "tap-hole" was opened and the bellows removed; the whole body of the furnace was then turned on its "trunnions," and the metal run off through the "tap-hole" into "molds" placed to receive it. This furnace was at a later period called a "calabash," and it may be regarded as the direct progenitor of the modern foundry "cupola"; and it is not more than forty years since a very similar apparatus was in use in this country for melting brass; but in this the furnace, after the metal was melted, was suspended by its "trunnions" to a crane, and, being without a "tap-hole," the metal was run into the molds by inclining the furnace sufficiently to allow it to run over the top.

The reader must not infer that the primitive lever crane, illustrated in Fig. 8, was the only form known in the early part of the last century; as, on the contrary, Agricola, more than one hundred and fifty years before, described and illustrated several cranes of much more elaborate construction, some of which are quite similar in idea to foundry cranes in common use at the present day.

As in some degree illustrative of the rude picturesqueness of all the belongings of the old type of charcoal furnace, we have engraved (Fig. 9) a view of the remains of one situated on the Conemaugh River, in western Pennsylvania. The "hot-blast stove" which surmounts the "stack" is evidence that the spirit of modern progress has wrestled with the inevitable in vain, and the broken "blast-pipes," grass-grown "stack," and luxuriant surrounding vegetation, show that the breath of igneous life has passed away forever, and that Nature is claiming her own again.

The old colonial iron-works were of necessity located in valleys where advantage could be taken of a natural fall of water, or where a stream could be dammed at small expense; and, although when measured by the standards of our time, they were very imperfect in plan, rude in structure, uncouth and clumsy as to machinery, yet these primitive works produced metal, albeit small in quantity (eight to ten tons per week), of a quality that has never been excelled by the colossal furnaces and forges of this day and generation. The progress of improvement in those early days was slow, painful, and uncertain. Steam and Electricity, twin sons of modern civilization, were unborn, and the mechanic arts only represented what was possible to be accomplished by

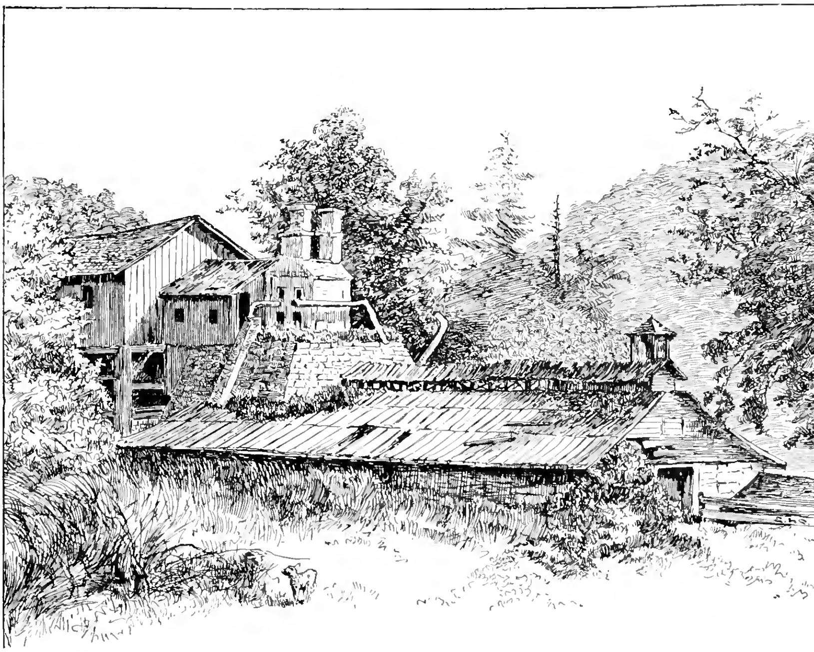

FIG. 9.—OLD FURNACE ON THE CONEMAUGH.

the skill and muscular energy of men and animals. The wonder-working mechanisms now known as "machine-tools" were unimagined, and men wrought laboriously, by dint of the acute eye, cunning hand, strong arm, and stalwart courage, at subduing the savagery of a continent.

In presence of so many obstacles, and having such plentiful lack of nearly everything that modern engineers and artisans would regard as indispensable, the failure of the pioneer American sons of Vulcan would have occasioned no surprise, and their triumphant success is therefore all the greater wonder.

Thus far we have spoken chiefly of the furnaces and apparatus used in colonial times for the production of cast iron in its three forms of "sowe iron," "pig iron,"* and "castings," and have

* Pig iron is usually in the form of roughly semi-cylindrical masses about two and one half feet in length, and weighing in the vicinity of one hundred pounds each. These

briefly alluded to the fact that the earliest known method of obtaining iron from its ores produced a forgeable and weldable metal. We now purpose to describe more fully this primitive process, and to illustrate some of the machinery by which the iron produced was wrought* into bars of various sizes and forms. The process illustrated by Fig. 1 (page 147) is with slight modifications still in use in Africa, and from iron produced in this rude way the native Kaffir blacksmiths forge the heads of such "assagais" or spears as were used with deadly effect in the last conflict of the Zulus with England.

The quantity of iron that can be obtained by this simple process as the result of a single operation is quite limited and only sufficient for the forging of implements of very moderate size; but, as mankind gradually improved the conditions of life, the necessity for larger masses of the most potential metallic factor of civilization became more and more urgent, and to meet this demand there was revealed to some receptive and executive intelligence among men † the means by which such larger masses of iron could be obtained, and the "Catalan forge" ‡ or "blomary fire" # supplied for a time the world's needs for an improved process of manufacturing wrought iron. A section of one of these "forges" or "blomary fires" is represented by Fig. 10. The cavity of the hearth *d*, in the earlier forges, was lined with fire-resisting stone (usually some variety of sandstone); but later, fire-bricks were used, and still later, iron plates, which in the more recent "blomaries" have been made hollow and kept cool by a circulation of water. The *tuyère*, *b*, was placed from seven to eight inches above the bottom of the hearth, and was contrived so that its inclination could be varied at pleasure. The blast was produced

"pigs" derive their name from being cast in the same "bed" with the "sow," in side-channels communicating with the main trench.

* The term wrought iron doubtless originated as a descriptive designation from the necessity of distinguishing iron that could be readily "wrought" or shaped as desired from "sowe" or other forms of "cast iron" which could not be "wrought" under the hammer.

† Such persons are in these days called "inventors," and are generally regarded as the originators of the various ideas and devices which they urge upon the attention of mankind; but they are, strictly speaking, simply vehicles and avenues by and through which knowledge continually comes into the world for the steady advancement of civilization. Columbus did not "invent" America, and was no more responsible for its existence than the trumpet for the note of command that issues from its resounding muzzle. This is not said in disparagement of "inventors," but only in explanation of their true function and relation to civilization. Certainly no more honorable fame, or honest wealth, can fall to any man than that which comes from being the recognized means by which beneficent knowledge is discovered; therefore all honors and rewards to such "inventors," the true prophets of science and human progress.

‡ Derives its name from the province of Catalonia, in the north of Spain, where it has been used for many centuries.

From the Anglo-Saxon *blôma*, a mass or lump; *isenes blôma*, a mass or lump of iron.

either by the "*trompe*" or by wooden or leather bellows; and sometimes by what some writers—in utter defiance of Euclid and all his disciples—have called "square wooden cylinders," worked by rude water-wheels.

The ores most frequently reduced in these "blomary fires" were the rich magnetites containing about seventy per cent of iron, although poorer ores could be, and oftentimes were, used. Sometimes the ore was employed in the "raw state" (i. e., just as

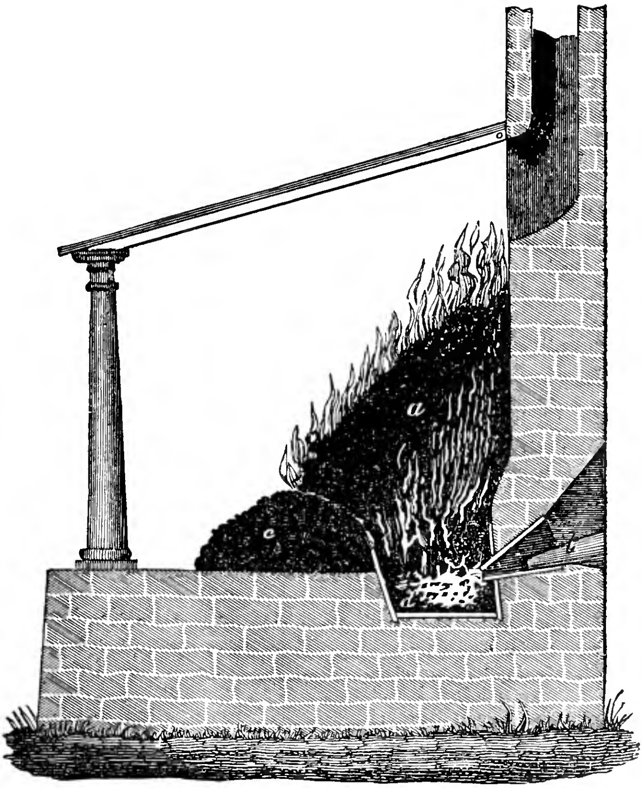

Fig. 10.—A Blomary Fire.

it is taken from the mine), but the best practice was to subject it to a preliminary roasting in heaps. The operation of smelting the ore, or more properly deoxidizing it (for the metallic iron obtained in these "fires" was not the result of a true fusion), was substantially as follows, viz.: The bottom and sides of the "hearth" having been lined with a thick coating of charcoal dust, it was then filled with charcoal, upon which crushed ore was thrown, and kept in place by a dam of charcoal dust (*c*, Fig. 10). The fire was blown gently at first, and as the heat increased a more powerful blast was employed; ore and coal were added from time to time as the work progressed, and sometimes the mass of fuel and ore was heaped up three or four feet. After an hour and a half or two hours of blowing, most of the iron in the ore was found in a pasty condition at the bottom of the hearth, in a bath of liquid "cinder" formed from the impurities of the ore and the ashes of the fuel; the blast was then augmented and most of the "cinder" drawn off through a "tap-hole" in the front side of the hearth, after which the pasty iron was lifted by bars until it was opposite or somewhat above the *tuyère*, and was there heated and manipulated until it became a spongy but coherent mass or "ball" of forgeable iron, twelve or fifteen inches in diameter, whose numerous

Fig. 11.—Removing a Ball from a Catalan Forge.

cavities were filled with a more or less fluid cinder. For the purpose of expelling this "cinder" and imparting greater density and coherence to the iron, the ball was then removed from the fire (Fig. 11) and taken to a "trip-hammer"* (Fig. 12) and "shingled."

The resulting "bloom," roughly cylindrical or rectangular in shape, represented about three fourths of the iron contained in the ore used; the remainder went into the cinder and was lost. The weight of the "bloom" obtained at a single operation was usually from three hundred to three hundred and fifty pounds.

* So called from the fact that it is "tripped up" and allowed to fall, by the pins on the rim of the smaller of the two wheels shown in the illustration (Fig. 12). This form of hammer is also called a "shingling hammer."

The simplicity and consequent cheapness of construction of the blomary fires caused them to be largely employed in the early years of the iron manufacture in America; and a few, that have superior advantages for obtaining supplies of ore and fuel, remain active at the present time.* We are told † that in 1731 there were in all New England "six furnaces for hollow ware and nineteen forges or blomaries for bar iron. At that time there were no furnaces for pig iron exclusively nor any refineries of pig metal; there was one slitting-mill and a manufacture of nails." In that year there were no iron-works in New York, and but a few in New Jersey (one furnace and "several forges"); in Pennsylvania there were one furnace and three "forges." At the same time there were two "furnaces" and one "blomary" in Delaware, and two "furnaces" and two "blomaries" in Maryland, and in Virginia there were three "blast-furnaces" and one "air furnace" (a form of reverberatory furnace), "but no forge." The fifteen "furnaces" and thirty "blomaries" above enumerated represented the growth of the iron industry of America during the eighty-six years following its birth at Lynn.

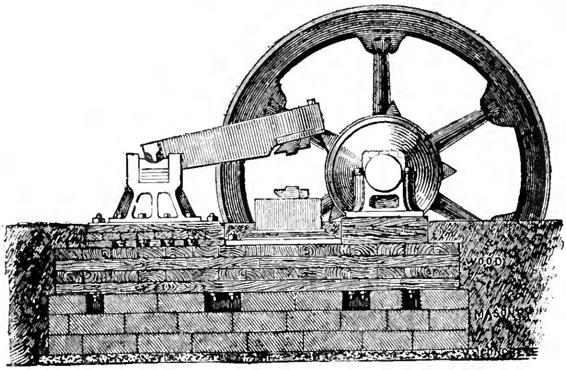

Fig. 12.—A Trip-Hammer.

As the result of a superabundance of painful pondering, supplemented by a proportional volume of conservative hesitation and doubt, the manufacture of iron slowly increased, not only in America, but in the world at large; and soon after the "blomary process" had been generally recognized as the most satisfactory method of making iron, the growing needs of expanding civilization began to demand some means by which the more abundant ores that were not so rich in iron as those required by

* The "Catalan forge" or "blomary fire" has been an important factor in the growth of the iron industry of the United States, but it belongs to an industrial stage of the past. In 1856 J. P. Lesley, Secretary of the American Iron Association, reported two hundred and four blomaries in active work (in nine States), whose product for that year was 28,633 tons: many of these works must have been idle, as the product seems a very low one, averaging but one hundred and forty tons each. In 1889 James M. Swank, Vice-President and General Manager of the American Iron and Steel Association, reports but five forges (four in New York and one in Tennessee), producing iron direct from the ore; their united product being 12,407 net tons of blooms.

† Bishop's History of American Manufactures.

the "blomary fires" could be easily and cheaply smelted, and at the same time furnish larger masses of forgeable metal than the process in common use could supply.

This demand led to the invention of the "Osmund * furnace" and the "Stücköfen." † Both of these furnaces are of German origin, but it is not absolutely certain which is the older; for, although we hear of the "Stücköfen" as early as the year 1000, we find no mention of the "Osmund furnace" (by that name) until early in the eighteenth century, though furnaces of similar size and construction (called "Blaseofen" and Bauernofen) had been in use in Germany for several hundred years; and as the natural course of development of all mechanisms and apparatus is from the smaller to the larger, or from the less to the more efficient, it is extremely probable that the "Osmund furnace" was the immediate successor of the "blomary" and that the "Stücköfen" (a much larger and loftier construction) followed pretty closely in point of time after it.

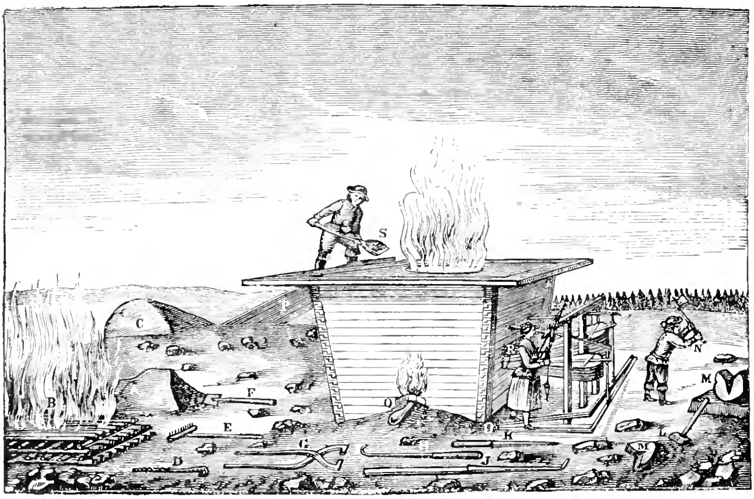

Fig. 13.—An Osmund Furnace.

The general construction and equipment of an "Osmund furnace" are represented in Fig. 13. This engraving is a copy of one given by Percy ‡ as a reproduction of a drawing accompanying a report of a Swedish mining surveyor to the Royal Board of Iron Trade in 1732. A similar engraving (but three times the size) is contained in the work of Swedenborg, who gives in addition a

* From the German "*Ose*," ring, and "*Mund*," mouth.

† From the German "*Stück*," bloom (piece), and "*Ofen*," furnace.

‡ Metallurgy of Iron and Steel. By John Percy, M. D., F. R. S. London, 1864, p. 321.

vertical section of the furnace, which is also copied by Percy, and which we present in Fig. 14.

In Fig. 13, A is a heap of uncalcined bog-ore; B, a calcining fire of wood on which the ore is "roasted"; C, a heap of calcined bog-ore; D, earth-borer, used to search for ores; E, charcoal-rake; F, iron shovel; G, tongs for drawing the "bloom" from the hearth of the furnace; H, cinder-hook, also used in handling the bloom; K, bar, used for clearing the cinder-notch and *tuyère;* L, large sledge for hammering the "bloom"; M M, the lump of iron; N, the hatchet; O, the treadles for working the bellows; P, bridge of planks; Q, tap-hole for cinder; R, *tuyère;* S, wooden shovel for filling ore into the furnace. It will be noticed that the

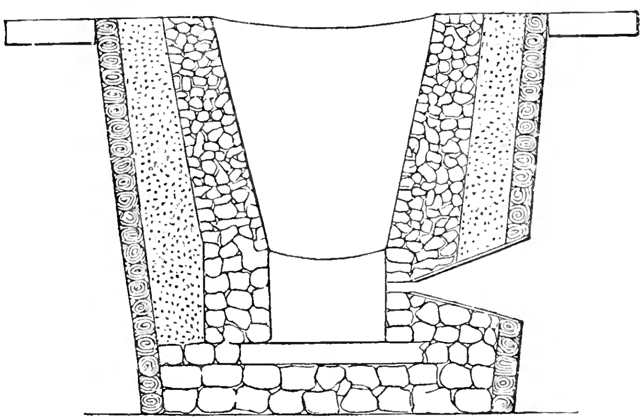

Fig. 14.—Vertical Section of an Osmund Furnace.

masonry of the furnace is incased by timber-work, which is locked together at the angles. This construction, rude and unsatisfactory as it appears to eyes familiar with the iron-bound furnace-stacks of the present day, was a not uncommon one as applied to the earlier blast-furnaces in this country; and those in which it was employed were called "log-furnaces," to distinguish them from furnaces whose exterior walls were entirely of masonry. The bellows, in the case of the Osmund furnace illustrated, appear to have been operated by a woman, who, by stepping first on one of the treadles and then on the other, thus raised by her weight the bellows boards alternately; while at the same time her nimble fingers were busy with distaff and spindle. We think we are entirely safe in saying that this method of blowing a furnace was never employed in America.

It is not certain that the Osmund furnace was ever used in this country, as we find no mention of any furnace having been erected called by that name; but, when we consider its simplicity and consequent cheapness of construction, and that it was (according to Swedenborg) especially adapted to the working of bog-ores, large quantities of which were actually smelted in New England, it does not seem at all improbable that furnaces of similar form may have been used there for smelting such ores; and the fact that this furnace produced wrought iron in masses of considerable weight would make it of especial utility in connection with forges, which were quite numerous in the New England colonies at the beginning of the eighteenth century.

The Stücköfen was an enlargement upward of the Osmund furnace, and may be pretty accurately described, as one Osmund furnace inverted upon another, its interior form being that of two cones united at their bases, a hearth similar to that of an Osmund furnace being formed at the lower part. We have no certain information that the Stücköfen was ever used in this country; but as this furnace was well known in Europe, where it had been in use for several centuries, those interested in the earlier smelting enterprises in the American colonies must have been acquainted with its construction, and it is very probable that some of the earlier blast-furnaces were Stücköfens under another name. The fact that this furnace could be so worked as to produce either cast or wrought iron, as desired, would make it especially valuable in a new country, where there was not sufficient demand for either metal to keep a furnace constantly employed. Besides those already enumerated, there was another method of producing a "bloom" of forgeable iron; viz., by the remelting of "sowe" or "pig" iron in a "Catalan forge" or "blomary fire." In colonial times this operation was largely used and was often described as "refining," and the premises in which it was carried on were frequently called a "refinery"; but the reader must not confound this term with that applied to a comparatively modern apparatus of quite different construction and purpose, which we will describe later.

This old refining process * consisted substantially of melting the pig iron with charcoal, and then directing the blast upon the melted iron—which was stirred occasionally by proper iron tools—until its impurities in a great degree were expelled, and a spongy mass of forgeable iron was formed (quite similar, in fact, to that obtained when ore alone was used), which could be hammered into a "bloom."

Thus far we have confined ourselves mainly to a description of methods and apparatus for the production of "sowe" or "pig" iron and "blooms," which were either in actual use in America

* This process is even now worked to a limited extent, but its use is steadily declining. Mr. Swank reports that "the production of blooms and billets from pig and scrap iron in 1889 was 23,853 net tons, against 25,787 tons in 1888, and 28,218 tons in 1887."

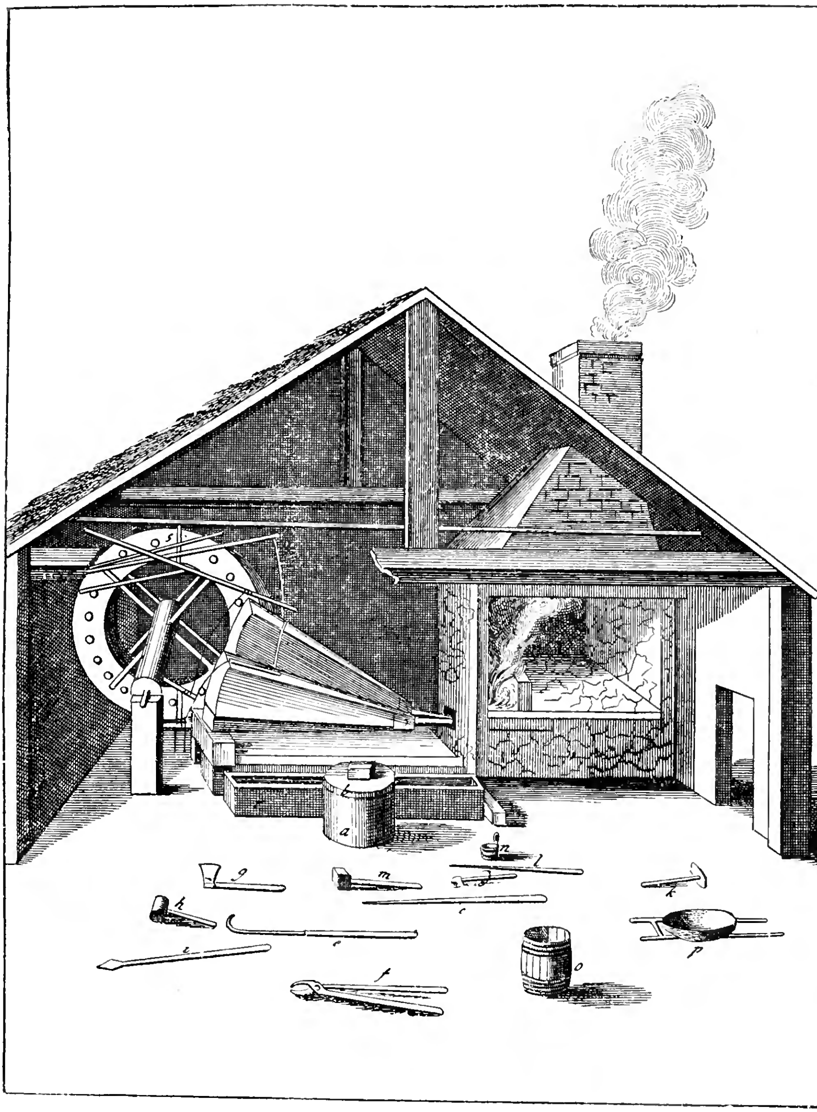

Fig. 15.—A Forge in 1734.

during the century following the erection of the first iron-works at Lynn, in 1645, or were coeval therewith. We now purpose to describe the early ways and means, and some of the more important improvements thereon, by which "blooms" produced by either of the before-mentioned methods were shaped into bars and rods of various forms and dimensions. The simplest means used for this purpose consisted of a hammer wielded by the muscular energy of a blacksmith.

The "hammer" was undoubtedly the first tool invented by man, and it is still not only the simplest but positively the most important tool in use; without its pioneering blows other tools could not have been fashioned, and the materials of which they are composed would have lain dormant in the earth's crust forever; for the ringing of anvils under the beating of hammers was the absolutely essential overture to the grand opera of the civilization of the human race.

If it was intended that the metal be drawn out on an anvil by "hand-hammers" and "sledges," the soft mass of iron, as it was taken from the "blomary-fire" or other furnace in which it was reduced from the ore, was cut by means of a hatchet (as shown at M N, Fig. 13) into parts not too cumbrous to be handled by ordinary smiths' tools; these pieces were then heated in a fire of larger size, blown by more powerful bellows than were commonly used by a blacksmith. One of these enlarged smiths' fires is shown in Fig. 15 (taken from Swedenborg's De Ferro), and the tools used are shown scattered about the floor. It will be noted that there are two bellows, and that these are operated by a water-wheel.

When, as was usually the case, the purpose was to make from the iron bars and rods for the general purposes of trade, the bloom resulting from shingling (as before described) the spongy mass of crude iron was reheated and drawn into the desired shape under the blows of a ponderous piece of machinery called a trip-hammer. This, although of the same name, was quite different in construction from that already described as having been used for shingling the crude iron. One of these forge trip-hammers is shown in Fig. 16, in which H is the head of the hammer; this was sometimes made of wrought iron, but more often was cast of the proper form and provided with an aperture through which the wooden beam forming the "helve" was passed and secured by wedges. W is the anvil, and *a* the "bloom," whose movements are guided and controlled by the "hammer-man" (3); while his assistant (2) determines the rapidity and force of the blows, by varying the amount of water supplied to the water-wheel which actuates the hammer. The clumsy, heavily iron-hooped, wooden shaft Y, of the water-wheel, was in this instance placed parallel with the helve of the hammer. Fastened in the circumference of this shaft were a number of round wooden pins, which, as they successively came in contact with the under side of the helve, forcibly threw it up against the spring-beam, 13, whose recoil increased the velocity of descent of the hammer and consequently the force of the blow.

Unless the bars made were of very great thickness, only a part of the bloom could be drawn out before it became too cold to be hammered; in which case the bar, with that portion of the bloom which adhered to it, was taken to a fire and reheated; sometimes several of these reheatings were necessary before the

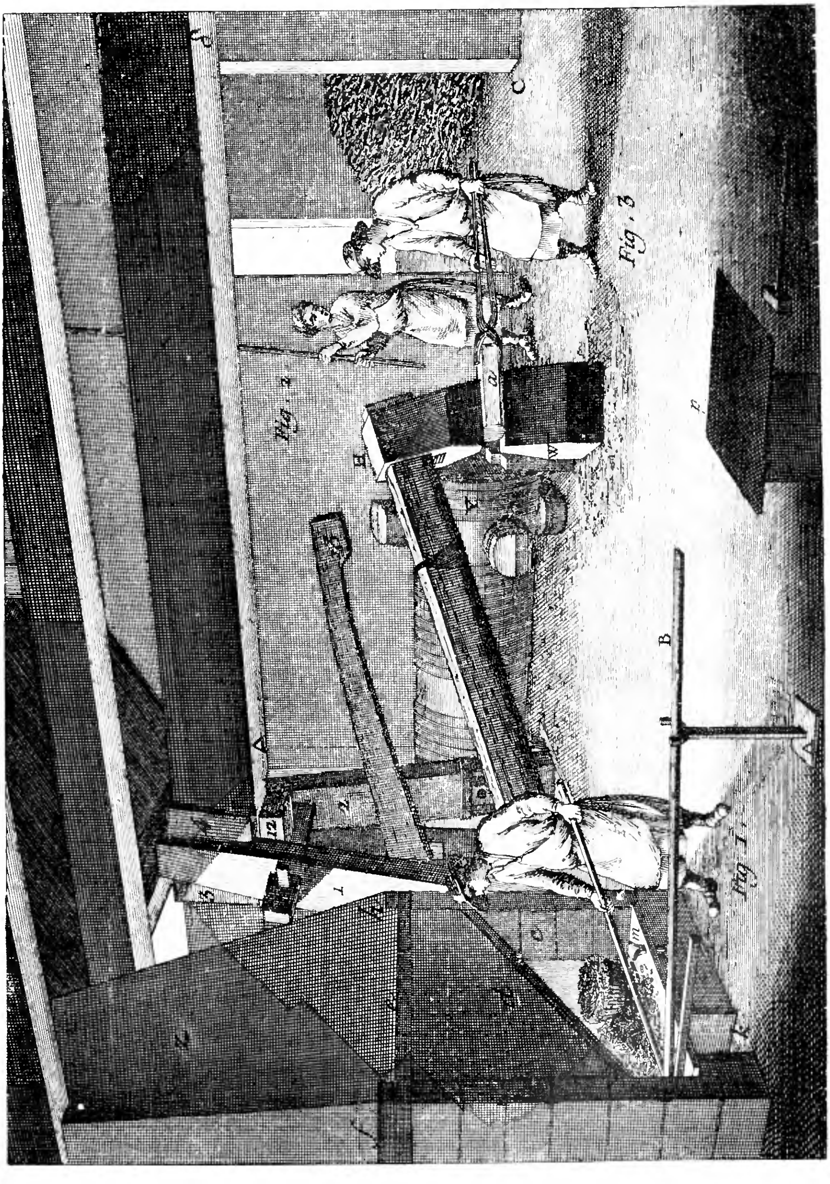

Fig. 16.—A Forge Trip-Hammer.

whole of the bloom was forged into a bar. At 1 (Fig. 16) is seen a bar, B, whose end is being reheated as described. Whenever it was desired to make round bars, the hammer was provided with a groove of nearly semicircular section, located on one side of the middle of its striking surface or "face"; and the anvil had a corresponding groove; the "bloom" was first drawn down on the plain part of the anvil to a square section, and then this square bar was rounded in the grooves of hammer and anvil.

[*To be continued.*]

WHAT SHALL WE DO WITH THE "DAGO"?

By APPLETON MORGAN.

THE very recent murder of David C. Hennessey, chief of police of the city of New Orleans, appears to direct public attention to a class of immigrants which has recently sought the hospitable ports of the United States, and, in connection with the constant questions of prison reform and prison economics, to justify a considerable and serious public attention.

The newspaper paragraph which tells what the man to be hanged at ten o'clock had for breakfast at eight, is doubtless appetizing to thousands of honest wage-workers who can not recall sitting down in all their lives to as sumptuous a bill of fare. The libraries of standard fiction provided for incarcerated felons are well enough; though, if the incarcerated felons, when liberated, are at once to take their position as leaders in progress and increasers of the public wealth, they might better be supplanted, perhaps, with works on mechanics and the mechanical motors, steam, electricity, etc. The point in civilization to which the world has arrived renders it impossible that the inmates of prisons should be starved, frozen, or tortured into imbecility. But the question as to how tenderly they should be treated, how delicately cared for, and how comfortably their bodily wants provided for, appears not yet to have been submitted to anything like a consensus of public opinion. Such question, as a matter of fact, appears to be left at large, until selected as a sentimental one for ladies and gentlemen of sympathetic natures and leisure for philanthrophies not otherwise bent; and the result is, that when anything is done it is done toward the adding of yet one more burden upon the law-abiding and uncriminal classes, to wit, the providing of increased consolations, if not luxuries, for their law-breaking and criminal brothers and sisters. When we tax the good man for the benefit of the bad man, we ought to tax him as lightly as possible. When the peaceful and useful citizen is assessed to build prisons for the house-breaker and molester of the public quiet, he doubtless should be assessed roundly enough to keep the unruly class secure from the facilities for working further mischief; and nobody will decline to go further, and say that the prison should be clean enough and well enough drained, and wholesome enough to prevent the criminals within—their active work of evil restrained—from negatively breeding infection among the honest people they no longer affirmatively and independently rob, disturb, and destroy. There ought to be no hesitation about going quite as far as this. The question is, How much further—with an honest regard for the rights of the non-law-breaker—may we proceed? A prison is not supposed to be a nice, cozy place to live in. It should not be a desirable place even to the class of people which criminals are bred from. Neither the criminal classes—nor the classes from which criminals come—live and dress warmly; their shoes are not dry, their bodies are not well kept and sleek and cleanly; their tables are not regularly or sumptuously or even wholesomely spread. Poverty certainly should not be allowed to aggravate or in any way influence the penalty for crime: but it would seem as if, in the enforcement of the penalty, it can not be entirely left out of the estimates taken by our law-makers, and this for certain reasons, of which the following are a few:

There is just now seeking these shores, in extraordinary numbers, a class of laborers who live more meanly than the imagination of the general public, in well-paid and well-fed America, can conceive. Every one who has visited the northern shore of the Mediterranean, in Italy, is familiar with the class called *lazzaroni*. It may be actually said that this class does not live in houses at all, does not know what a house means: except for shelter against inclement weather; that it has no use for roofs at all. Water, except as it falls from the heavens, it appears to know not in any external sense; and during the long summers and mild winters a wall or an alley is quite as convenient as, and much more available a shelter than, a roof. A gang of these people, "dagoes" as they are nicknamed (a corruption of *hidalgos*, which, though a Spanish and not an Italian word, once came to be sneeringly applied to a foreigner of Latin Europe out of his element), employed in building an American railroad, will find it necessary, in the new climate, to be provided with quarters of some sort; will herd together as tightly as they can dispose themselves, in anything which is covered by a roof, and every office of nature will be performed together in the same tumbled quarters. I once happened to witness the following incident: A small circus, with a few lions and tigers, exhibiting in a small town, near by where a railroad was being constructed, fed, as a part of its programme, these wild beasts. The bones which the beasts gnawed were left on the ground when the circus departed between two days. And the "dagoes" collected these bones and boiled them for their soup! What terrors have jails and prisons for such human beings?

What have they to lose by pilfering, assaulting, robbing, and murdering? So far as creature comforts are concerned, they live better and work about as much, have warmer clothing and better beds, in the meanest jail in the United States than they experience out of it. So far as the duration of life is concerned, they will probably live as long under a sentence of death as they do in the wretched filth they pile up around them, and in the rapid changes of our national weather. The *bric-à-brac* societies who have exhausted Ibsen, Browning, and the entire science of photography, and who are now devoting themselves to the comfort and well-being of malefactors, might possibly be in good part, were there any reasonable percentage of reformation in the ordinary penitentiary experience; if the enterprising burglar, after serving out his term, burglarized no more, or the cut-throat, released from a long penalty for his crime—as Mr. Gilbert would say—"loved to hear the little brook a-gurgling and to listen to the merry village chime"; but, as a matter of fact, he doesn't. But here is a practical problem quite in the line of refinement. Sooner or later, somebody in this country will be obliged to grapple with the problem of the "dago." Can he be kept out of jail? Can he be made a useful citizen by utilizing the leisure he spends in jails to educate him into some sort of comprehension of the new country in which he finds himself? The proposition that every jail and prison should be made reformatory as well as punitory in its character would require, one would be apt to say, some little looking into. The question as to whether states are bound to reform as well as punish, their wrong-doers, depends largely upon the wider question of the duties of a state to its citizens. The other considerations, as to whether a state should make its prisoners comfortable, should watch over their physical welfare, may be disposed of at once by citing the general propositions that, however models of what they ought to be in other respects, our jails ought to be somewhat more uncomfortable to the prisoner than the most comfortless hovel that the poverty of the habitual criminal provides; as, otherwise, there would never be a class of the community to whom a residence within prison walls would not be a change for the better. Jail soup may be thin, but let the man who loves not thin soup keep out of jail. And let the soup be not thicker than, at least, the thinnest obtainable outside. To reverse the old rhyme, in most cases "Stone walls *should* a prison make, and iron bars a cage." If flowers are to be distributed by kind-hearted ladies at Easter, let it be to the deserving who keep, rather than to the undeserving who keep not, the law of the land. Of course, these propositions are not meant to contemplate the abnormal instances of squalor and filth, which communities for their own preservation must treat with and rectify.

That question is disposed of by the Boards of Health, into whose province it would seem naturally to come.

Again, as to the duties owed by states to their citizens, two things are, or ought to be, beyond question: first, that the state should attempt the greatest good to the greatest number; and, second, that it should not discriminate against the innocent in favor of the wrong-doer. If, therefore, a state or community building a jail, is unable to provide elaborately organized and classified prisons to punish its wrong-doing citizens without taxing its honest and law-abiding citizens unduly, it would not seem to be its exact duty to do so. It should not impose unbearable or irksome burdens upon its citizens who need no reformation, for the purpose of experimenting upon those to whom reformation is desirable. It is undesirable that a prison should be so constituted or managed as to make its occupants, whether reformable or not, worse than when they entered its portals; but the tendency of human nature to retrograde rather than improve, is, probably, not less constant inside than outside of penitentiaries. So far as this tendency of human nature to retrograde can be shown to be largely enough re-enforced by non-classification of prisoners to work actual harm to the state, some classification ought to be attempted.

To argue as some of us do, for example, that the public revenue should be charged with the expense of building separate institutions for boys who, at ten years of age, have begun to burglarize, and for those who have begun to steal in broad daylight; to keep up with the legal difference between the two crimes; or that a further refinement of distinction should be made between the man who has once and the one who has twice robbed; or between the one who proposes on liberation to rob, and the one who proposes on liberation not to rob again, is not only to be impracticable, but to become absurd. To a philosophic mind this leads up to the doctrine of heredity, and the question whether the criminal classes, from generation to generation, are not always distinct, to about the same proportion, from the law-abiding class. Whether the law-abiding, industrious, and honest classes should be burdened with increased taxes to try and save the freshman criminal from becoming a sophomore, and the junior from graduation into the senior class of crime, is a question much too profound to be solved from any standpoint, especially from the standpoint of the excellent gentlemen who make speeches to the philanthropical societies—which speeches are referred to committees, whose reports are printed in unlimited pamphlets; still less from the standpoint of the pamphlets themselves.

So long as governments owe a duty to all classes of the commonwealth alike, and to no one over and above or as against another, they can not be governed by sentiment, be optimists or pessimists, or theorists of any sort. They must be governed by principles. In the application of those principles they must be guarded by facts; and governments, unhappily, have no other means of being informed of facts except by statistics. If figures should happen to show that one in every four hundred citizens of a given community is a law-breaker, and that this proportion had not varied perceptibly in, say, twenty-five years, would that community be justified in erecting a system of public buildings for the sake of experimenting toward a decrease of this percentage—buildings which must be paid for out of the pockets, not of the law-breakers who pay no taxes, but of the law-observers who do? Possibly the tax-payers of the community would think not.

Nothing, of course, should be allowed to antagonize the laws of humanity, or, in a large sense, the laws of charity. But to whom is charity to be shown? Which class of the community deserves the largest charity? Is it Christian to expect the honest man, who forever pays tithes of his toil, to experiment on the reformation of the man whose ancestral traditions compel or incite him to toil not, but to break in and help himself to the fruits of the honest man's toil? Let the largest charity be meted out to all. But no charity can be meted out with equity, without some regard to deserts. It must not be forgotten, even by the charitable, that if any preference is to be shown by the commonwealth, it is for those who keep rather than those who break its statutes, and for them that observe rather than for them that ignore the unwritten laws that govern human relations. Ten minutes' inspection of the haunts of crime in a city like New York, for example, ought to convince the daintiest of *bric-à-brac* ladies and gentlemen of the danger of a too well-appointed, a too substantially fed, and a too well-libraried prison. The slums where the cold of winter alternates only with the fetid and noxious odors of summer, would, to most of us, destroy confidence at least in that homeliest of maxims, "If you don't like your jail, keep out of it." Certainly, the more we strip the penitentiary of its penances, the more stress we throw on the single element of disgrace to keep men out of jail. But the disgrace of serving a term of imprisonment is a matter which, unfortunately, partakes quite as largely of *bric-à-brac* as does the sentiment of the average prison reformer. What disgrace is a year or ten years in a prison to a nomad, a man from nowhere, who has no character to lose, who goes by as many names as he pleases and changes them as often as he likes? The problem remains. We must build prisons which, somehow or other, will be less desirable abiding-places than the slums. We can not starve prisoners, or turn them on wheels, or distort them with boots or thumb-screws. We can not freeze them nor roast them, nor feed them with miasmatic diseases. But, all the same, we must eventually find some principle, somewhere, by the practice of which, while meting out to the wrong-doer the penalty he has earned, we shall protect the revenues as well as the peace and the safety of the community.

All this is familiar reasoning enough. But the problem seems to increase to formidable dimensions just now with the new class of which we have spoken. What shall we do with the "dago"? This "dago," it seems, not only herds, but fights. The knife with which he cuts his bread he also uses to lop off another "dago's" finger or ear, or to slash another's cheek. He quarrels over his meals; and his game, whatever it is, which he plays with pennies after his meal is over, is carried on knife at hand. More even than this, he sleeps in herds; and if a "dago" in his sleep rolls up against another "dago," the two whip out their knives and settle it there and then; and, except a grunt at being disturbed, perhaps, no notice is taken by the twenty or fifty other "dagoes" in the apartment. He is quite as familiar with the sight of human blood as with the sight of the food he eats. His women follow him like dogs, expect no better treatment than dogs, and would not have the slightest idea how to conduct themselves without a succession of blows and kicks. Blows and kicks, indeed, are too common an experience with them for notice among "dagoes." When a woman is seriously hurt, she simply keeps out of sight somewhere till she is well enough for the kicking and striking to begin over again, and no notice whatever is taken of her absence meanwhile. The disappearance is perfectly well understood, and no questions are asked. The male "dago," when sober, instinctively retreats before his employer or boss, or any other man, and has no idea of assaulting him, or indeed of addressing him, or having any relations with him except to draw his pay. But, when infuriated with liquor, he will upon any fancied occasion use the only argument which he possesses—his knife. I say the only argument, for it is inevitable experience that he will not talk; however little or however much he may understand of what is said to him, he will pretend not to understand. He has a pretty clear idea of how much money is coming to him, and manages to convey that information to his paymaster. But it is rather dangerous for the paymaster to give him much less than the amount which, in his idea, is coming to him. He will refuse to accept it, withdraw, jabber and gesticulate, and it will be well for that paymaster to be on his guard until something representing that month's wages is accepted.

Now, when (as happens constantly in the course of the grading of a railroad by great swarms of these "dagoes") three or four hundred or less of these human beings are quartered for a month in the vicinity of some prosperous, quiet, and orderly little inland town, where the justice of the peace and the constable are farmers in the field or keepers of the country "store," or the village shoemaker and carpenter respectively—what happens? What, indeed, must happen? The "dago" will not resume work the day after his pay-day, which comes monthly. (Did it come weekly, he would not work at all, as will presently appear.) He takes his wages to the nearest village or community in which spirits, or what is called spirits, is sold. If it is not given him, he fights, is arrested, and locked up; if it is given him, he also fights, is arrested, and locked up. In either case he will be taken by the constable before the justice, and a little experience will convince these officials that the only safety for their community is to "fine" the "dago" what money he may happen to have in his pocket, for, until his money is gone, he will not return to his work. This programme is repeated month by month, until that section of the railroad is finished and the "dago" is moved to another, where another adjacent village must learn, by experience, how to protect itself precisely as did the last one. Local criminal laws seem, therefore, incompetent to deal with this "dago." He has apparently nothing to lose—and from any standpoint except his own, apparently something even to gain—by the most comfortless prison that American ingenuity can devise.

Although the argument from design has made great strides since the days of Dr. Paley's watch, there yet remains much in nature for science to explain by utilizing it. The constrictive force of the African python, for example, the aggravative energy of the New Jersey mosquito, or the tremulous force of the young ladies' Browning or Ibsen Club, for example, remain as yet to puzzle us; and possibly, on the whole, the argument may be stated as in that condition of compromise in which it appeared to the starving tramp who discovered a New England swamp full of whortleberries and rattlesnakes. Design had evidently placed the whortleberries there to save his life, but chance had dropped in the utterly purposeless rattlers. A somewhat corresponding mixture of good and evil appears to confront us in the very large importation lately of this curious people. It is to the eternal credit of King Victor Emanuel that he, first in history, utilized that class of his subjects which has been known from time immemorial as the *lazzaroni*. He put this entirely unattractive person, who till then had naught to do but accommodate himself to the weather, to work removing rock *débris* on the Mont Cenis Tunnel, and since he was, to that extent, a successful railroad man, the royal example has been followed over here, and, it can not be denied, with very considerable advantage. The dago class, by liberating a class of workmen of, say, one grade higher, has actually added to the country's creative wealth. But, when this *lazzarone* is imported into the United States and set to grading an American railway, he is found to possess characteristics which may not have interfered with his usefulness on the Mont Cenis Tunnel, but which here become exceedingly unpractical, not to say uncomfortable: and which may, as we have shown, even prove as large a problem in our criminal, as his advent was, no doubt, a happy thought in our industrial, economy.

THE IDENTITY OF LIGHT AND ELECTRICITY.*

BY HENRI HERTZ.

OUR first thought, when we speak of the relations of light and electricity, is of the electric light. That is not the subject of the present paper. The physicist thinks of the extremely delicate reciprocal actions of the two forces, such as the rotation by the current of the plane of polarization, or the variation under the influence of light of the resistance of a conductor. In these cases, however, the action is not direct, but a medium, ponderable matter, is interposed. There are other closer, more intimate relations between the two forces. It is my purpose to discuss the proposition that light is in its very essence an electrical phenomenon—whether it be the light of the sun, of a candle, or of a glowworm. Suppress electricity in the universe, light would disappear; suppress the luminiferous ether, electric and magnetic forces would cease to act through space. This theory is not of to-day or of yesterday, but has a long and instructive history. My own experiments only mark one of the steps in its development; and it is my purpose to retrace its whole evolution, not one of its phases only. It is not easy in a matter of this kind to be clear without omitting something essential. The phenomena to be considered take place in space, in the ether itself, and are not perceptible to the touch or the hearing or the sight. Reflection and reasoning may permit us to grasp them, but it is hard to make an exact description of them. We shall endeavor, therefore, to connect them with ideas that are already known to us. We refer, therefore, first to what we already know concerning light and electricity.

We know of a certainty that light is an undulatory movement, and that the undulations are transversal; we have determined their length and their velocity; and all that follows from

* A communication to the Sixty-second Congress of German Naturalists and Physicians, at Heidelberg.

these facts is equally certain. It is, therefore, sure that all of space that is accessible to us is not void, but is filled with a substance capable of entering into vibration—the ether. But while we have clear notions of the geometrical conditions of the phenomena that occur in this matter, their physical nature is very obscure; and what we know of the properties of the substance is full of contradictions. Comparing the waves of light with those of sound, they were regarded as elastic. But only longitudinal waves have been observed in fluids, and under the conditions of matter transverse waves are impossible in them. We have been obliged, therefore, to assume that the ether acts as a solid body. But when we regard the motions of the stars and endeavor to determine their conditions, we have to affirm that ether behaves like a perfect fluid. Without endeavoring at present to explain the contradiction that presents itself here, we pass to electricity; it may throw some light on the problem.

Most of the persons who ask what electricity is have no doubts respecting its real existence, and only expect a description of the properties of the singular substance. With scientific man, the problem takes the form, Does electricity really exist? Do not electric phenomena, like the other ones, go back to properties of ether and ponderable matter? Our knowledge does not as yet permit us to answer this question affirmatively. Material electricity still has a place in our conceptions, and the old and familiar idea of two kinds attracting and repelling one another, to which are attributed actions at a distance resembling intellectual qualities, still persists in current language. This theory dated from the time when Newton's law of gravitation having been confirmed by astronomy, the idea of action at a distance without the intervention of a medium was familiar. Electric and magnetic attractions were thought to obey the same law as gravitation; and, admitting a similar action at a distance, the phenomenon was supposed to be explained in the simplest manner, and the limits of knowledge on the subject to have been reached. A different aspect was presented when in this century the reciprocal action of currents and magnets was discovered, an action infinitely variable, in which motion and time played a great part. In the necessity of increasing the number of actions at a distance to complete the theory, the simplicity which gave it its scientific probability disappeared. Simple formulas and general and elementary laws were then sought, of which Weber's law was the most important tentative. Whatever may be thought of the exactness of these essays, they formed an exceptional system and a seductive whole, a magic circle, which one could not leave after having once entered it. The road was one that could not lead to the truth. It required a fresh mind to resist the current, one that could enter upon the study of the phenomena without preconceived opinions, and was capable of starting from what it observed, and not from what it had heard, read, or learned.

Faraday followed that course. He had heard that, in electrifying a body, something new was introduced into it; but he saw that the changes were external, and not within. He was told that the forces traversed space, but he remarked that the nature of the matter that filled the space had great influence on them. He had read that electricities existed, and that we only had to consider their properties; and yet he observed every day the effects of the forces without ever seeing the electricities themselves: in this way he reversed the proposition. The electric and magnetic forces became to him the only tangible reality, while electricity and magnetism fell to the rank of objects the existence of which is contestable. Considering these lines of forces, as he called them, independently of their cause, he regarded them under the form of states of space, tension, whorls, and currents, without occupying himself with what they might really be. He was satisfied with having established their existence, with observing their influence upon each other, their attractions for material bodies, and their propagation by the transmission of the excitation from one point of space to another. If it was objected that there could be no other state than absolute rest in empty space, he could answer: "Is space, then, empty? Does not the transmission of light force us to regard it as filled with matter? Can not the ether, which transmits the luminous waves, suffer modifications which we perceive under the form of electrical and magnetic actions? Is there not a relation between these modifications and these vibrations? Are not the luminous waves a kind of scintillation of these lines of force?" Such were the inductions and hypotheses which Faraday conceived. They were as yet only mental views; he applied himself earnestly to demonstrate them scientifically; and the relations of light, electricity, and magnetism became the favorite object of his studies.

The relation he found was not the one he sought. He continued his researches till age put an end to his labors. One of his principal questions was whether the transmission of electrical and magnetic forces is instantaneous. Is the magnetic field constituted at once to the limits of space whenever the current excites an electro-magnet? Or does the action first reach the nearer points and gradually propagate itself to the more remote ones? And is the sudden modification of the electric condition of a body felt simultaneously in identical variations, in all points of space, or is there a retardation augmented as the distance increases? In the latter case, the effect of the variation would be transmitted as a wave through space. Do such waves exist?

Faraday obtained no answer to his questions, but the solution of them is directly related to his theories. If electric waves crossing space exist, the independence of the forces that produce them is demonstrated. We know that the forces do not traverse vacua instantaneously, for we can follow their propagation each instant from one point to another. Faraday's problems can, however, be solved by very simple experiments. If they had occurred to him, his theory would have triumphed at once. The relation of light and electricity would have been so clear that it could not have escaped even a less perspicacious eye than his own.

But so simple and speedy a way was not yet open to science. The first experiments brought no solution, and the current view was inconsistent with Faraday's ideas. In affirming that electric forces could exist independent of corresponding fluids, he contradicted the theory generally received at the time. A fundamental discussion of either hypothesis promised to be only a barren speculation. How much, then, should we admire the man who had the sagacity to co-ordinate these two hypotheses, apparently so distantly separated, so that they should eventually support one another, and a theory come out of them to which it should be impossible to deny probability! This man was Clerk Maxwell, whose Mathematical Theory of Light was published in 1865. We can not study the theory without feeling that mathematical formulas have a life of their own, and that they appear sometimes more intelligent than we ourselves, and even than the master who established them, giving out more than he looked for in them. Direction was given to Maxwell's researches by the fact that magnetic forces are produced from electricity in motion, and electric forces from magnetism in motion, but the effects were not appreciable except at great velocities. The idea of velocity, therefore, enters into the relation between electricity and magnetism, and the constant determining this relation, which is always found in it, is a velocity of enormous value. The velocity of electricity had been determined by delicate researches, and found equal to that of light. A disciple of Faraday could not fail to explain this coincidence by supposing that the same ether carried the electric forces and light. Hence the most important optical constant already existed in the electrical formulas. Maxwell labored to confirm this connection between the two orders of phenomena. He extended the electrical formulas so as to make them express, along with all the known phenomena, an entire class of hypothetical facts—electrical undulations. He figured them as transversal waves, the length of which might have any value, but which propagated themselves through the ether at a constant velocity, that of light. It was then possible for Maxwell to demonstrate that there really exist in nature undulations possessing those properties, although we were not in the habit of regarding them as electrical phenomena, and gave them the name of light. If Maxwell's electrical theory was rejected, there was no more reason for accepting his views concerning light. In like manner, if it was affirmed that light is a phenomenon of an elastic nature, his theory of electricity became impossible. But when his theory was studied without prepossession with the ideas that were current, all the parts could be seen to lend one another a mutual support, like the stones of a vault, and the whole resembled a gigantic arch thrown across the unknown, and uniting two known truths.

The difficulty of the theory did not permit it at first to acquire a large number of partisans. But after its inner sense was discerned it was followed out to its ultimate consequences, and then the value of its fundamental hypotheses was tested. Experiments were at first limited to a few propositions, the accessory parts of the theory. I have compared Maxwell's system to an arch traversing an abyss of the unknown. I might add that it was some time before the abutments could be connected. It was thus put in a position where it could support itself, but the span was too wide to permit any new structure to be built upon it. To accomplish that object pillars were needed, rising from the ground, to support the middle of the arch. The demonstration of the possibility of obtaining electrical or magnetic effects directly from light would constitute one of the pillars and confirm the theory; it would have immediately established the electrical part, and indirectly the optical part of it. The completion and symmetry of the structure demanded the building of both the pillars to which we compare these principles, but one was enough to begin with. The construction of the former pillar has not yet been undertaken; but after a multitude of researches a solid base has been found for the second, with sufficiently ample foundations, on which a part of the pillar has been raised. With the co-operation of many workers it will soon reach the top of the arch and afford support to the weight of the edifice which is to be raised upon it.

I have had the privilege of taking part in this portion of the work. To this fact I owe it that I am now laying my ideas before you; and I hope that I may be excused if I try at present to direct all attention to this part of the edifice. I shall unhappily be obliged, for want of time, to omit the labors of a large number of seekers, and shall be unable to show to what extent my experiments had been prepared for by my predecessors, and how near some of them had come to a definite result.

It does not at first seem so difficult to show whether propagation of electrical or magnetic forces is or is not instantaneous; to discharge a Leyden jar, and observe whether there is any delay in the response of an electroscope a little distance off; or to observe the needle while a remote electro-magnet is excited. But these experiments, and others like them, have been tried without any interval being determined between the cause and the effect. An upholder of Maxwell's theory understands that such failures are inevitable, and arise from the enormous rapidity of the transmission. We can only perceive the discharge of a Leyden jar, or the excitation of an electro-magnet, from a moderate distance, say, of ten metres. But light, and electricity as well, according to the theory, pass over such a space in a thirty-millionth of a second. So short an interval of time can be neither perceived nor measured directly. Furthermore, we have no signals by which to define that instant. We do not make a big chalk-mark when we want to tell off a tenth of a millimetre. It would be quite as absurd, in determining a duration of a thousandth of a second, to depend on the sound of a large bell to mark the beginning of the moment.

The time required for the discharge of a Leyden jar is, according to our common means of observation, infinitely short. That does not mean that it is not equal to the thirty-millionth of a second; and, for the present case, it would be more than a thousand times too long. But Nature furnishes us another resource. It has been long known that the Leyden discharge is not uniform, but is composed, like the sound of a bell, of a number of vibrations of partial discharges, which succeed one another at even intervals of time. Electricity is capable, then, of imitating elastic phenomena. The duration of each vibration is much less than that of the whole discharge; we might, therefore, try a vibration as a standard. Unfortunately, the shortest vibrations that have been observed are of a millionth of a second. While one of these vibrations is going on. its effect is propagated to three hundred metres; while within the limited space of a laboratory it will appear simultaneous with the vibration. Known phenomena, then, gave no aid, and it was necessary to look for another way. The difficulty was turned by applying the discovery that vibrations are produced in any conductor as well as by the discharge of the Leyden jar, and often much more rapidly. When the conductor of an electrical machine is discharged, vibrations are produced, the duration of which varies from the hundred-millionth to the millionth of a second. They are, it is true, only isolated vibrations that are extinguished rapidly—a condition unfavorable for the experiment. But success would be possible even if we could observe only two or three of the vibrations. In the same way, in acoustics, we substitute, when we want to, brief signals sounded on wood for the lengthened sounds of whistles and cords.

We now possess signals in comparison with which the thirty-millionth of a second is no longer a short interval. But they would be of little use if we were not able to compare them at that distance of about ten metres which we have proposed to ourselves. The means employed for this purpose are very simple. We fix a conductor—for instance, a straight metallic wire, having a slight interruption at one point—at the place where we desire to perceive the signal. When the electrical field is rapidly varied, a spark appears in the conductor.

The means of observation could be pointed out only by experiment. Theoretically it was hard to imagine it. The sparks are, in fact, microscopic, being hardly a hundredth of a millimetre long, and they continue less than a millionth of a second. It is extremely hard to conceive them as visible. Yet they can be seen, in a dark room and by an eye at rest. On so light a thread is hung the success of our undertaking. We had in the beginning a number of questions to answer. Under what conditions are the vibrations strongest? We must try to secure those conditions. What form should the conductor have? The phenomena will vary as we use straight or bent wires, or conductors of other forms. The form being determined upon, of what size should our conductor be? This is not a matter of indifference, for we shall see that we can not study all the vibrations with the same conductor. There are relations between the two elements like the phenomenon of resonance in acoustics. Lastly, in how many different positions can we arrange this conductor? We shall see the sparks at times increase in intensity, or become weaker, or disappear. I can not enter into these details; they are simply accessory to the theory as a whole. They are of importance only to the operator, and are simply properties of his instrument.

What the experimenter will educe from his process will depend on his knowledge of his means of action. The study of the instrument and the answers to the questions I have just mentioned therefore formed the most considerable part of my labor. This task having been disposed of, the solution of the problem was before me.

A physicist, given a number of diapasons and resonators, will find no difficulty in demonstrating that sound is not propagated instantaneously, even in the restricted space of a room. Having set the diapason in vibration, he goes with his resonator to different parts of the room and observes the intensity of the sound. He perceives that it becomes weak in some places, and infers from this that each vibration is annulled by another of later origin, which has reached the spot by a shorter route. If less time is taken in traversing the shorter road, propagation is not instantaneous, and the question is answered. But our physicist will then show us that the points of silence succeed one another at equal intervals, and will deduce from this the length of the wave; and, if he knows the duration of the vibrations of the diapason, he will obtain, by these data, the velocity of the sound. We operate in the same way with our electrical vibrations. The conductor in which the vibrations are made fills the part of the diapason. The circuit, interrupted at a certain point, takes the place of the resonator, and may be called the electric resonator. We remark that sparks fly out at some points in the chamber, and quiet prevails in others. We notice that the spots inactive, electrically, follow in a regular order. We deduce from this, that the propagation is not instantaneous; and we can even measure the length of the wave. We are asked whether the waves are longitudinal or transversal. Let us place our metallic wire in two different positions in the same place in the room. It indicates an electrical excitation the first time, but not the second. Nothing more is needed to decide the question. The waves are transversal. If we are asked to give the velocity of propagation, we have only to multiply the length of wave which we have just measured by the duration of the vibration, which we can calculate. We find the velocity like that of light. If the correctness of this calculation is doubted, we have another resource. The velocity of electric waves in metallic wires is enormous, and quite equal to their velocity in the air. Further than this, it was directly measured a considerable time ago; for the problem was easily studied on wires kilometres long. We therefore have a purely experimental valuation of this velocity, and, although the result is only approximate, it does not contradict the one we have just got.

These experiments are all very simple at the bottom, and yet they have most important consequences. They overthrow every theory that assumes that electrical forces traverse space instantaneously, and mark the triumph of Maxwell's system. It is no longer a simple thread of union between two orders of distinct phenomena. While his theory of light seemed at first to be probable, it is now hard not to regard it as true. But it may be that in approaching this end we shall be able to dispense with the support of the theory. Our experiments took place very near that neutral zone which, according to it, unites the domains of light and electricity. Only one step remains to be taken to land in this domain of optics, which is well known to us. It will not be superfluous. There are many friends of Nature interested in the problem of light who are capable of comprehending simple experiments, but to whom Maxwell's theory is still unintelligible. Moreover, the scientific method requires us to avoid roundabout ways when it is possible to follow a direct one. If, then, we succeed in producing phenomena like those of light by means of electric waves, all theorizing becomes superfluous; the identity of the two orders springs from the experiments themselves. Success in this way also is possible. Let us place the conductor that produces the variation of the electric condition in the focus of a large concave mirror. The electric waves will join, and will come forth from the mirror in the form of a rectilinear beam. We can, it is true, neither see nor touch this beam; but we know it is there, because we can see sparks pass from it to the conductors which it meets; and it becomes sensible when we arm ourselves with our electrical resonator. Its properties are all those of a luminous ray. We can, by turning the mirror, send it into different directions. Studying the path which it follows, we may see that it is propagated in a straight line. If we interpose conducting bodies in its way, they will not let it pass; they cast a shadow, but do not destroy the ray; they reflect it, and we can follow the reflected beam and satisfy ourselves that it follows the laws of the reflection of light. We can also refract it as we do light; and, as we use a prism to study the refraction of light, so we do here. But the dimensions of the waves and of the beam force us to take a very voluminous prism. So we select a cheap substance—pitch or asphalt. Finally, we can study on our ray phenomena which we have heretofore observed only in light, those of polarization. If we place a kind of metallic grate in the track of the beam, we can observe our electric resonator emitting sparks or remaining quiescent in obedience to the same geometric laws as govern the variations in the glow of a ray of light in passing through a polarizing apparatus.

In making these experiments we have come into the domain of optics. In describing them we speak no longer of electricity, but use the language of optics. We do not say that the currents pass along the conductors, or that the electricities unite. We see nothing but undulations crossing one another in space, separating, combining, and re-enforcing or weakening one another. Having started from the domain of pure electricity, we have come step by step to purely optical phenomena. The passage is made for henceforth, and the road has become easy. The identification of light and electricity, which science suspected and theory predicted, has been definitely established, made perceptible to our senses and intelligible to the mind. From the heights we have attained, where the two orders of phenomena are blended, we look into the domains of optics and electricity. They seem more vast than we had supposed them to be. Optics is no longer limited to ethereal undulations of a few fractions of a millimetre, but includes waves the length of which is measured in decimetres, metres, and kilometres. But, enlarged as it is, it is still only an appendage to electricity. That gains yet more advantage. We shall hereafter see electricity in a thousand conditions in which we did not before suspect it. Every blaze, every luminous atom becomes an electrical phenomenon. Even if a body does not cast light, it is a center of electrical action if it radiates heat. The domain of electricity is therefore extended over all nature, and even possesses us; for is not the eye, in fact, an electrical organ? Such are the results which we obtain in these questions of detail; those that concern the philosophy of science are no less important.

One of our most difficult problems is that of actions at a distance. Are they real? Of all those which seemed indisputable to us, gravitation is the only one that is left. Will it also escape? The laws of its action themselves provoke the thought. The nature of electricity is another of these great Unknowns. It reverts to the question of the condition of electrical and magnetic forces in space. Behind this rises the most important problem of all—that of the nature and properties of the substance that fills space, of the ether, its structure, its movements, and its limits—if it has any. We see this question becoming more and more dominant over all the others. The knowledge of the ether seems destined not only to reveal to us the condition of the imponderable substance, but also the nature of matter itself and its inherent properties—weight and inertia.

The ancient systems of physics summarized everything as formed of water and fire. Modern physics will shortly be asking if all existing things are not modalities of the ether. Here lies the ultimate end of our knowledge, the culmination of all that we can hope to learn. Shall we ever reach it? Soon? We do not know. But we have reached a greater height than ever before, and we have gained a solid point of support which will make our upward progress and search for new truths easier. The way that is opening before us is not too steep, and the next step does not look inaccessible. There is a numerous company of seekers full of ardor and knowledge; and we wait with confident hope all the attempts that will be made in that direction.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

A new method of disposing of the dead, which he calls "sanitary entombment," is proposed by the Rev. Charles R. Treat. It is intended to combine the feature of deposition in a tomb with desiccation, whereby the preservation is secured of the body freed from all noxious properties. An arrangement of buildings is contemplated, like that of the Campo Santo of Pisa, so constructed that anhydrous air may enter the tomb and pass over the body to absorb all moisture and morbific matter, which it will convey to a separate structure, where all shall be consumed in a furnace. Thus the form of the body may be retained, while all of it that is subject to decay is cremated.

DEFENSES OF BURROWING SPIDERS.*

By HENRY C. McCOOK, D. D.

THE simplest form of burrow is that of the *Tarantulas*, which represent the largest known spiders. These huge araneads appear to depend wholly upon their size to resist the assaults of enemies who invade their den. At least I have not found satisfactory evidence that they erect any artificial barrier over the entrance to their tunnels.

A more complicated burrow, and one better serving for defense, is that of *Leptopelma cavicula* of northern Africa. The drawing (Fig. 1) shows a section view of the upper part of the burrow, the entrance to which is without any door or other defense as in the case of the tarantulas. The burrow descends perpendicularly for a little way, but at the top a special branch diverges laterally, which curves and again descends perpendicularly for a considerable distance. At the summit of this second and parallel perpendicular tube another branch issues, inclining upward toward the surface. A glance at this structure, if we suppose it to be characteristic of the species, and not an accidental formation, will show that it makes an admirable protection against heavy rains, which sink away into the first burrow as a kind of reservoir, enabling the spider to escape by the diverging branch. Against enemies who pursue it into its den, this structure also presents an effectual defense, for, while an enemy naturally would rush downward into the first direct passage, the spider may escape by the lateral branch. Supposing that the enemy, observing the mistake, ascends and follows along the branches, the spider has the opportunity to push up into the second branch while the pursuer, again following its natural instinct, would rush down the second perpendicular tube. I am here in the region of conjecture, but perhaps no better explanation presents itself.

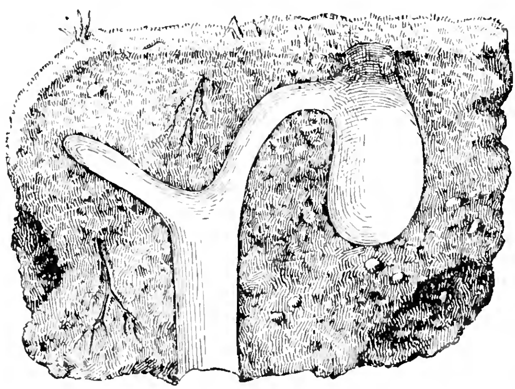

FIG. 1.—BURROW OF *Leptopelma cavicula*. Section view of upper part.

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* Reprinted from Vol. II of American Spiders and their Spinning-work, by the kind permission of the author, to whom we are also indebted for the accompanying illustrations.

A third stage in the development of this defensive industry is represented at Fig. 2, which shows the external tube of *Leptopelma elongata.* This is simply a lily-shaped tube of pure white spinning-work, rising directly above the burrow, and supported by surrounding foliage. The purpose of this structure has not been positively determined. As able a naturalist as A. R. Wallace has conjectured that it may be deceptive in its uses, its resemblance to a flower attracting to it insects, which are thus preyed upon by the proprietor. Such elevated objects are certainly apt to attract insects, who are disposed to alight upon them without regard to their promise of providing food. But I am inclined to believe that Leptopelma's silken lily serves as a watch-tower from which she can observe the approach of enemies and make good her escape in time. Moreover, I believe that it is possible for her to pull together the sides of the sheeted turret and thus erect a barrier between herself and some of her feebler pursuers.

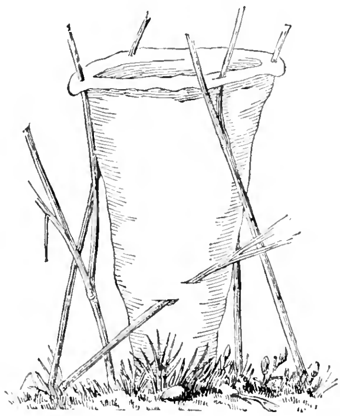

Fig. 2.—Lily-shaped Tube of *Leptopelma elongata.*

Another form of defensive industry is presented at Fig. 3, which is the exterior part of the turret tube of *Dolichoscaptus inops* (Simon). This is about an inch in height, and is composed of mingled chippage and mud, a sort of *débris* of chopped straw and soil.

Fig. 3.—Turret of *Dolichoscaptus inops.* (Natural size.)

A still further stage is shown at Fig. 4, which represents a columnar turret of *Dolichoscaptus latastei*, several inches high. This resembles the tower of the preceding species, but adds thereto a hinged covering after the manner of a trap-door. This turret is also composed of chippage and *débris* of various sorts gathered from the neighborhood, and is supported upon the surrounding foliage, which in the drawing is a plant of *Lavandula dentata.* All the uses to which such an elevated structure can be put are served by this ingenious structure, and, in addition, the trap-door is manifestly intended to defend the inmate from the assaults of enemies.

We come now to the trap-door nests of *Nemesia meridionalis*, and other species making traps of the wafer type, as so fully described by Moggridge. Here we have simply a dropping away of the turret of *Dolichoscaptus*, and the use of the burrow independently of the same, but with the trap-door retained. In the species studied by Moggridge a single burrow is the ordinary rule; but there are many variations, some of which are manifestly characteristic of species, and others which are probably occasional and accidental.

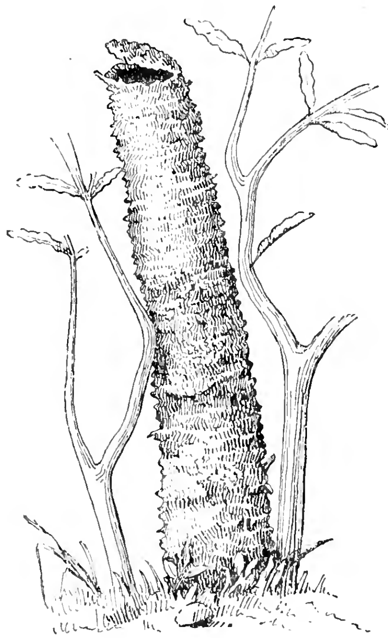

Fig. 4.—Turret, with Trap-door, of *Dolichoscaptus latastei*, supported on a plant—four inches high. (After Simon.)

A variation described by Mr. Simon is shown at Fig. 5, the nest of *Stothis astuta*, which inhabits the forest of Cartuche, near Carácas, South America. The drawing shows a section of the burrow, indicating the curved course, and also the two wafer-like trap-doors habitually placed at either end. That this peculiar industry is defensive is probable, for we can readily imagine the spider disappearing within its den at one door, and, if its pursuer should succeed in entering the same, escaping at the other. We might, without much stress of imagination, carry the conception a little further, and suppose, again, the enemy making its exit from one door and the spider again descending into its burrow by the other. This game of bopeep might evidently be played to the great advantage of the trap-door spider, and manifest disconcerting of its enemy.

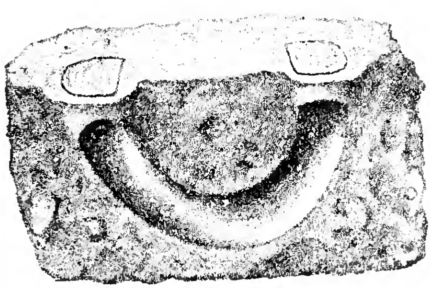

Fig. 5.—Section View of Curved Burrow of *Stothis astuta*, showing Double Trap-door Entrance.

Simon gives an interesting example of the ability of a spider of this species to change its habit and adapt its industry to unexpected surroundings. The species commonly seeks dark and damp localities, and digs in vegetable earth a burrow not very deep. The nest was begun underneath a stone in soil which was so rocky as to be impenetrable. Not wishing to change its site, and not to be cheated out of its proposed domicile, Stothis proceeded to erect a cylindrical case about two inches long, composed of a conglomerate gathered from surrounding particles of soil and vegetable chippage. These were cunningly wrought together, the whole structure silk-lined, and the characteristic trap-doors hung, one at either end. Thus, while varying her habit in so far as to build a surface tunnel instead of a subterranean one, Stothis preserved her defensive habit of erecting for herself a back door by which she could retreat in case of invasion at the front door.

The burrow of *Stothis cenobita* (Simon) is simply a rounded chamber underneath the surface, and closed by a trap-door, which differs in no particular, as far as I can observe, from the ordinary trap-door of the American *Cteniza californica.*

It is difficult to say what may be the enemies of the trap-door spider against which such ingenious architecture has been reared and such vigilant watch is exercised. But the quite general testimony is that these spiders leave their tubes at night and go forth in search of prey; or, as in other cases, open the lids of their tunnels and spread straggling lines near by, upon which passing insects are entangled and delayed long enough to allow the spiders to pounce upon them from their open caves. If we credit these accounts, we might infer that the enemies which the trap-door spiders most dread are not such as are abroad at night. Evidently the creatures are fearless at that time—a state of mind which doubtless results from their knowledge that they are comparatively free from their worst enemies. The enemies which they most dread may therefore be reasonably looked for among diurnal creatures, and not among those of nocturnal habits. Among these foes, at least one of the most formidable and irresistible is a diurnal insect, the female of the terrible digger wasp, which I do not doubt will be found to store trap-door spiders, as well as tarantulas and lycosids. There is no evidence known to me that *Pepsis formosa* invades the tunnel of the *Mygalidæ* in order to dig them out. Such an act is not, indeed, beyond her powers; and, reasoning from the conduct of *Elis 4-notata,* it is highly probable. But we are not yet warranted in attributing the habit to her. Some lizard or mammal that might pull open the trap with its claws may be looked for as also a probable enemy against which trap-door spiders erect and defend their ingenious barrier.

At all events, the spider herself is well aware of these enemies. Abbé Sauvages invariably found, when he attempted to open the door of the nest of "the mason-spider" (*Nemesia* and *Cteniza*), that the mother was on guard, holding down the lid of her tunnel with great force. In his efforts to pull the trap-door up, the spider would jerk it down, and there would be an alternate opening and shutting of the nest until his purpose was accomplished. It is the habit, according to Moggridge, Simon, and all observers who have noted the point at all, for these animals to hang back downward upon the inner surface of the door. In many nests which I have seen there are holes along the outer or free edge of the door—the part directly opposite the hinge—which mark the points at which, probably, the fangs of the spider had been fixed, in order to give it a strong purchase against intruders.

One of the most curious examples of relation of structure to enemies, or perhaps of the reaction of hostile environment and agents upon structure, is found in a territelarian spider (*Cyclocosmia truncata*). This aranead, according to Hentz, dwells like others of its kind in cylindrical cavities in the earth. Though many specimens were found, he never saw any lid or closure to the aperture of its dwelling. The very singular formation of its abdomen, which is as hard as leather behind, and is truncated to form a perfect circle, induced Hentz to believe that when in danger it closes its dwelling with that part of its body instead of with a trap-door or lid. This conjecture, of course, needs confirmation, though it seems not improbable; and one may imagine the intellectual confusion of a pursuing enemy which finds its prey suddenly disappearing within a hole in the ground, but which, when investigated, presents nothing but a level surface where certainly a hole ought to have been! The dorsal view of the spider is given at Fig. 6, the side view at Fig. 7; and a diagrammatic section view of the creature is drawn at Fig. 8, as it probably would appear when closing up the opening to its burrow.

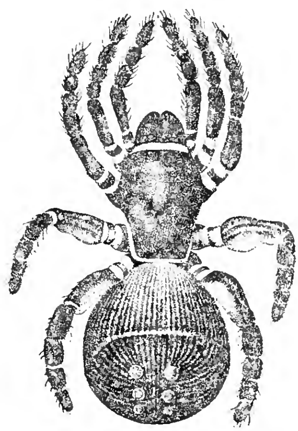

FIG. 6.—*Cyclocosmia truncata*.

FIG. 7.—SIDE VIEW OF SAME. (After Hentz.)

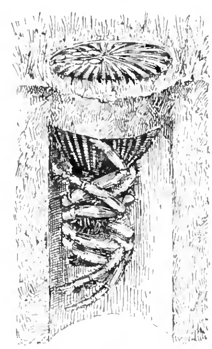

FIG. 8.—DIAGRAMMATIC VIEW OF TRUNCATA, CLOSING HER BURROW WITH HER ABDOMEN.

ARCHITECTURE AND THE ENVIRONMENT.

By BARR FERREE.

THE natural conditions that are essential for successful building have never been better set forth than in a letter written by the consul Pliny to his friend Gallus in the early part of the first century of our era, in which he describes his newly-finished villa of Laurentinum.

"You are surprised," he writes, "that I am so fond of my Laurentinum, or (if you like the appellation better) my Laurens; but you will cease to wonder when I acquaint you with the beauty of the villa, the advantages of its situation, and the extensive prospect of the sea-coast. It is but seventeen miles from Rome; so that, having finished my affairs in town, I can pass my evenings here, without breaking in upon the business of the day. There are two different roads to it: if you go by that of Laurentum, you must turn off at the fourteenth mile-stone; if by Ostia, at the eleventh. Both of them are, in some parts, sandy, which makes it somewhat heavy and tedious, if you travel in a carriage, but easy and pleasant to those who ride on horseback.

"The landscape on all sides is extremely diversified; the prospect in some places being confined by woods, in others extending over large and beautiful meadows, where numberless flocks of sheep and herds of cattle, which the severity of the winter has driven from the mountains, fatten in the vernal warmth of this rich pasturage. My villa is large enough to afford all desirable accommodations, without being extensive. The porch before it is plain, but not mean, through which you enter into a portico in the form of the letter D, which includes a small but agreeable area.

"This affords a very commodious retreat in bad weather, not only as it is inclosed with windows, but particularly as it is sheltered by an extraordinary projection of the roof. From the middle of this portico you pass into an inward court, extremely pleasant, and thence into a handsome hall, which runs out toward the sea; so that, when there is a southwest wind, it is gently washed with the waves which spend themselves at the foot of it.

"On every side of this hall there are either folding-doors or windows equally large, by which means you have a view from the front and the two sides, as it were, of three different seas; from the back part you see the middle court, the portico, and the area; and by another view, you look through the portico into the porch, whence the prospect is terminated by the woods and mountains which are seen at a distance. On the left hand of this hall, somewhat farther from the sea, lies a large drawing-room; and beyond that a second of smaller size, which has one window to the rising and another to the setting sun; this has likewise a prospect of the sea, but, being at a greater distance, is less incommoded by it. The angle which the projection of the hall forms with this drawing-room, retains and increases the warmth of the sun; and hither my family retreat in winter to perform their exercises: it is sheltered from all winds except those which are generally attended with clouds, so that nothing can render this place useless, but what, at the same time, destroys the fair weather.

"Contiguous to this is a room forming the segment of a circle, the windows of which are so placed as to receive the sun the whole day; in the walls are contrived a sort of cases, which contain a collection of those authors whose works can never be read too often. Thence you pass into a bedchamber through a passage which, being boarded and suspended, as it were, over a stove which runs underneath, tempers the heat which it receives and conveys to all parts of this room. The remainder of this side of the house is appropriated to the use of my slaves and freedmen; but most of the apartments are neat enough to receive any of my friends.

"In the opposite wing is a room ornamented in very elegant taste: next to which lies another room, which, though large for a parlor, makes but a moderate dining-room; it is exceedingly well warmed and enlightened, not only by the direct rays of the sun, but by their reflection from the sea. Beyond is a bedchamber, together with its anteroom, the height of which renders it cool in summer; as its being sheltered on all sides from the winds makes it warm in winter. To this apartment another of the same sort is joined by one common wall. Thence you enter into the grand and spacious cooling-room belonging to the bath, from the opposite walls of which two round basins project, sufficiently large to swim in. Contiguous to this is the perfuming-room, then the sweating-room, and next to that the furnace which conveys the heat to the baths; adjoining, are two other little bathing-rooms, fitted up in an elegant rather than costly manner; annexed to this is a warm bath of extraordinary workmanship, wherein one may swim and have a prospect, at the same time, of the sea.

"Not far hence stands the tennis court, which lies open to the warmth of the afternoon sun. Thence you ascend a sort of turret, containing two entire apartments below; and there are the same number above, besides a dining-room which commands a very extensive prospect of the sea, together with the beautiful villas that stand interspersed upon the coast. At the other end is a second turret, in which is a room that receives the rising and the setting sun. Behind this is a large repository, near to which is a gallery of curiosities, and underneath a spacious dining-room, where the roaring of the sea, even in a storm, is heard but faintly; it looks upon the garden and the *gestatio* which surrounds the garden. The *gestatio* is encompassed with a box-tree hedge, and, where that is decayed, with rosemary; for the box, in those parts which are sheltered by the buildings, preserves its verdure perfectly well; but where, by an open situation, it lies exposed to the spray of the sea, though at a great distance, it entirely withers.

"Between the garden and this *gestatio* runs a shady plantation of vines, the alley of which is so soft that you may walk barefoot upon it without any injury. The garden is chiefly planted with fig and mulberry trees, to which this soil is as favorable as it is averse to all others. In this place is a banqueting-room, which, though it stands remote from the sea, enjoys a prospect nothing inferior to that view: two apartments run around the back part of it, the windows whereof look upon the entrance of the villa, and into a very pleasant kitchen garden. Hence an inclosed portico extends, which by its great length you might suppose erected for the use of the public. It has a range of windows on each side, but on that which looks toward the sea they are double the number of those next the garden. When the weather is fair and serene, these are all thrown open; but if it blows, those on the side the wind sets are shut, while the others remain unclosed without any inconvenience.

"Before this portico lies a terrace, perfumed with violets, and warmed by the reflection of the sun from the portico, which, as it retains the rays, so it keeps off the northeast wind; and it is as warm on this side as it is cool on the opposite; in the same manner it proves a defense against the southwest; and thus, in short, by means of its several sides, breaks the force of the winds from whatsoever point they blow. These are some of its winter advantages: they are still more considerable in summer; for at that season it throws a shade upon the terrace during all the forenoon, as it defends the *gestatio*, and that part of the garden which lies contiguous to it, from the afternoon sun, and casts a greater or less shade, as the day either increases or decreases; but the portico itself is then coolest when the sun is most scorching—that is, when its rays fall directly upon the roof. To these, its benefits, I must not forget to add that, by setting open the windows, the western breezes have a free draught, and by that means the inclosed air is prevented from stagnating. On the upper end of the terrace and portico stands a detached building in the garden, which I call my favorite; and indeed it is particularly so, having erected it myself. It contains a very warm winter room, one side of which looks upon the terrace, the other has a view of the sea, and both lie exposed to the sun. Through the folding-doors you see the opposite chamber, and from the window is a prospect of the inclosed portico.

"On that side next the sea, and opposite to the middle wall, stands a little elegant recess, which, by means of a glass door and a curtain, is either laid into the adjoining room, or separated from it. It contains a couch and two chairs. As you lie upon this couch, from the feet you have a prospect of the sea; if you look behind, you see the neighboring villas; and from the head you have a view of the woods; these three views may be seen either distinctly from so many different windows in the room, or blended together in one confused prospect. Adjoining this is a bedchamber, which neither the voice of the servants, the murmuring of the sea, nor even the roaring of a tempest can reach; not lightning, nor the day itself, can penetrate it, unless you open the windows. This profound tranquillity is occasioned by a passage which separates the wall of this chamber from that of the garden; and thus, by means of that intervening space, every noise is precluded. Annexed to this is a small stove-room, which, by opening a little window, warms the bedchamber to the degree of heat required. Beyond this lie a chamber and antechamber, which enjoy the sun, though obliquely indeed, from the time it rises till the afternoon. When I retire to this garden apartment, I fancy myself a hundred miles from my own house, and take particular pleasure in it at the feast of the Saturnalia, when, by the license of that season of festivity, every other part of my villa resounds with the mirth of my domestics; thus I neither interrupt their diversions nor they my studies."

This remarkable letter was written in a civilization different from ours, when society and culture were developed in another spirit; yet the principles it so clearly illustrates are as much in force to-day as they were then, and the lessons it teaches as important to us as they were interesting and profitable to the friend to whom they were addressed. It matters not that the description is of a building erected more than eighteen hundred years ago, which has long since passed from the face of the earth. The truths involved in its construction are as real to-day as when the letter was freshly written, and, great as is its archæological interest, its chief merit is the admirable way in which it describes the model dwelling. Pliny was not an architect, but he was a man of keen observation, a student of nature, and possessed of sound common sense, which he never exercised to better advantage than in the erection of this building. His description shows us that utility is the chief consideration, first, last, and all the time, that should be observed in constructing a house. Coupled with this are the conditions imposed by the environment, the taking advantage of the natural situation, the direction of the wind, the heat of the sun, the requirements of temperature and climate, all of which must receive due attention in good and economic building. Ornamentation, decoration, design, æsthetic effects, and other elements which are popularly supposed to compose architecture, are either neglected altogether or put to one side as matters which may receive attention after essential things have been considered. The Romans were fond of ornament, they loved to overload their structures with decorations of all kinds, and the number of statues employed in some of their public buildings was prodigious; but Pliny's letter shows that there were at least some among them who looked at architecture through the lens of common sense, and it is to them we must go in our search after truth.

Adaptation to its use was the chief element in Pliny's villa, the basis on which it rested, and the plan on which it was designed. There was no insistence on the beautiful or the elevation of artistic form to the chief place, but everything was arranged as convenience dictated or sense suggested, and all was in consequence admirably suited to the requirements of the owner. It was in these things that he found satisfaction, while if any part was arranged with elegance, so much the better; but as long as he was comfortable, as long as his windows opened on refreshing views, as long as every advantage was taken of the shade in summer or the heat of the sun in winter, as long as there were convenient and accessible places of retreat as well as ample rooms in which to entertain the guests, there was no fault to be found, and, as the owner was satisfied, who could complain?

The pleasure that Pliny derived from his villa is in striking contrast to the dissatisfaction that is expressed with modern buildings of all kinds—not dwellings alone, but stores and offices, churches and public buildings; with those erected in an inexpensive way, and those on which unlimited sums have been expended. The fault-finding is not a subdued murmur, but is general and outspoken, and, in the absence of any other object, is aimed at the architect, sometimes with a vigor that should be sufficient to arrest his attention. And the architects are largely to blame; for, as the leaders in the architectural movement, they naturally have a fuller acquaintance with the subject than a man who builds but one house in a lifetime, and, if they do not correct errors in construction, it is difficult to see who else is to be held responsible. The reasons for this state of things are obvious. Every man who undertakes to build a house seeks to make it a model dwelling in which the faults of every other building he is acquainted with will be corrected, and everything arranged to suit his ideas of comfort and utility. He begins with well-defined views, knows exactly what he wants, and lays them before the architect. The latter undertakes to please his client as best he may and prepares—a design. Possibly the plan is in accordance with the programme laid down, but it is by a picturesque exterior, a pleasing elevation, a beautiful drawing, that he hopes to captivate the eye and fancy of his customer. Other architects have made their reputation by their exteriors, and the most successful of all has obtained his fame by some great structure whose façade surpasses in beauty any offered by his competitors. Like a flock of sheep blindly following the leader, they go on preparing design after design, such as it is supposed the client will like, until an immense portfolio of pictures will be accumulated which may be very pleasing to look at, but which are simply drawings intended to catch the eye. The plan, the arrangement of the parts of the house, the convenience cf the occupants, and all similar questions are too frequently left to be filled in afterward, and made to fit the exterior instead of the exterior being made to express them.

Architecture, in fact, has ceased to be an art, and has become a fashion. We have styles in architecture just as we have styles in dress, and the changes in public taste are as capricious in the one as in the other. The rule of fashion is the most arbitrary and idiotic form of government to which human beings have ever submitted themselves, and it is not less so in architecture than in dress. Our buildings are put up now in one style, now in another, not because one is more suited to the purpose of the structure, not because it is better adapted to the climate, not because it more freely expresses our culture and our civilization, but because we want a change—because our streets are growing monotonous, because we must alter our structures to conform to the new style, and thereby give evidence of an improved taste and furnish profitable work for the architect and good jobs for the laboring man. As to what is behind all this—the structure itself, the part which calls the façade into being, to which it is really not more than a lid or screen to shut out inquisitive eyes—it does not matter. An Italian front does not necessarily imply an Italian house, nor a Moorish façade suggest the rich, luxurious, sensual life of the south. Variety is indeed the spice of life, and it is an admirable idea to give a diversity to our streets and erect ornamental façades to our buildings; but when we pass over all thought of convenience, of utility, of adaptation to natural conditions, and judge of buildings solely because one is better looking than another, we have passed the dividing line between sense and absurdity.

From the modern point of view it is a misfortune that buildings must be used. Were they only intended to be looked at, could they but be preserved in glass cases in the galleries of some gigantic museum, there would be no complaints, no fault-findings, no grumblings. If houses were not to live in, architects could pursue their occupations without inconvenience, and design fronts and windows and turrets and all sorts of knickknacks to their hearts' content. Unfortunately, this ideal state can never be realized; and, as people must conform to the designs of architects—must have turrets where they do not want them, windows where they are least needed, and all sorts of beautifications because they are in the latest style—there is constant conflict between builder and occupant, between architect and client. Nor could anything else be expected when buildings are judged solely by their æsthetic appearance. The history of architecture carries the comforting assurance that structures can be both beautiful and useful; and, in fact, in the best buildings the two elements are so closely united as to be scarcely distinguished. In our time, however, attention is paid to only one of them, and it is, therefore, impossible to obtain satisfactory results.

Writers on architecture make a broad distinction between construction and architecture, claiming that they are two different things, and that, while all architecture is construction, all construction is not architecture. Never was a difference productive of more perverted ideas. A factory is not architectural, because it is plain, unadorned construction. Put on some ornament, add a fancy roof, a cornice, and a balcony, and it at once becomes architectural, though none of these things have aught to do with the uses of the building, but frequently conflict with them. Such a definition may be maintained in order to have certain limitations, but it is clearly absurd to say that a building only properly comes within the province of architecture when certain adjuncts are added to it which, while they may increase its æsthetic appearance, detract from its usefulness.

The history of architecture is the story of the attempt of man to adapt his life to the environment in which he is placed. The Abipone under his mat, the Assyrian in his thick-walled house of brick, the Roman in his conveniently arranged villa, the mediæval baron in his castle, the French monarch in his richly appointed palace, are but so many instances of the influence of climate and geological conditions, nature of the soil, products of the land, extent of intercourse with other peoples, temperature, rainfall, manner of living, and many other phenomena which have caused the evolution of various grades of society, and which thus express themselves in visible form. In Assyria the buildings were of clay, because that was the only substance the land afforded. In Greece they were of stone, because it was abundant and easily obtained. The mediæval baron intrenched himself in a heavily guarded fortress, because the country was in an unsettled condition and was infested with freebooters. A change passed over society; laws were enforced, police regulations made, society became settled and calm, fortifications disappeared, and in their place arose châteaux and pleasant villas that were admirably suited to a free and peaceful life. Each style, in fact, originated in the various operations of natural conditions; each form had an evolution of its own, that had as definite and as readily ascertained causes as those which produced the evolution of any other form of culture. Reason and common sense, usefulness and intention, were the great factors on which all architecture rested; and when these things were neglected—when an arbitrary decree of fashion or the development of a new "taste" became the criterion by which all buildings were judged—architecture fell. This calamity occurred with the introduction of the Renaissance in the fifteenth century, and its results are still apparent.

Natural conditions are apt to be forgotten in this busy life of ours. We have no time to spend in applying the problems of perspective to architecture as did the ancient Greeks when they used curved lines instead of straight, in order to correct the distortion caused by distance. Our crowded cities, where land has reached fabulous prices per foot, afford no opportunity for taking advantage of the conveniences of an ample site. But, though we may not be able to concern ourselves with such matters, there are a multitude of other details that can be attended to which are now more or less neglected, and which, were they intelligently treated, would remove much of the present reproach from our architecture.

For many hundred years architecture has been occupied with solving problems presented by Nature. In earlier times life was comparatively simple, and artificial needs were few and easily satisfied. Now, however, we have countless mechanical contrivances that have entered closely into our lives, and the problems of architecture take a different range. Steam and electricity have revolutionized society. They have brought the furthermost parts of the earth into intimate connection. Our lives are one continuous hurry, and the laggard is soon left behind in the rapid march of progress. In the cities land is scarce and valuable, and room is only to be had by expanding upward instead of laterally. Inventive genius has supplied us with elevators, steam heat, electric light. Questions of public safety, correct sanitation, guards against fire, protection against burglary, safe means of rapid ingress and egress, have formed other conditions. The spread of manufactures, the making of artificial building materials, as iron and glass, have given us new forces. New methods of business and the constant and rapid introduction of new occupations have presented fresh problems with which to deal. The increase of great corporations, the building of railroads, new forms of transportation by water, the changes of life in every state, have caused new difficulties for the architect, all of which must be correctly solved if we are to make any true progress.

In our houses, stores, office-buildings, hotels, homes, factories, machine-shops, depots of construction, warehouses, churches, dwellings, and places of amusement, there is a constant need for the application of new ideas and the devising of new methods. The work that is before our architects is immense, and the way in which they apply themselves to it will largely influence our future advancement. Yet in the face of all this the battle of the styles waxes furious; and if one obtains a handsomer building than his neighbor, he is told not to complain of its inconveniences, but to be satisfied that he has got so much. There never was a time when the need of a practical architecture was more pressing than now, and there never was a time when it was so persistently neglected.

And what is a practical architecture? Is it one in which beauty is sacrificed to utility, where plainness is to be preferred to ornament, where art is subordinated to engineering? Not at all; we can have beauty and utility, art and engineering, all in one building, and still be practical and in line with good architectural work. It is true that many "practical" buildings are extremely ugly, and many great works of engineering eminently hideous. It is small wonder at times that there is a revulsion against the practical and a demand for more of the beautiful; but the error here is as great as when beauty is sacrificed to utility. Use is by no means synonymous with ugliness, and it is quite as important to combat such a view as to condemn beautiful things because they are useless. Practical architecture does not imply any compromise between the two elements, but it does imply a strict application of common sense to all material things. There is no reason why architecture should be denied the treatment from the point of view of sound sense that is given to every other department of thought and progress; it is too closely connected with the necessities of life to be made the victim of absurdity.

There is scarcely a limit to the number of examples of the neglect of natural conditions that may be gathered from the architecture that prevails among us. In the search for the beautiful, the demand for impressive façades, the taste for complicated ornament, and a most singular appreciation of the odd, the grotesque, and the ugly, there is little attention paid to matters which seem self-evident and are of really vital importance. Windows are arranged to suit a symmetrical façade, whether they are just what are needed for the rooms or not, and, even where it is possible, little attention is given to the direction of the sunlight in order that the living-rooms may receive the full benefit of the natural warmth, nor are those rooms where it is not needed, or minor offices, relegated to the exposed side. The most important external feature, the door, is seldom adjusted to the climate. Even in large office-buildings, hotels, and churches, where there should be ample space for every structural convenience, the door is frequently of cramped dimensions, and, instead of being preceded by a porch, which would be an integral part of the architecture, and which is absolutely essential in our long, cold, damp winters, is boarded up with "storm-doors" that are not only hideous in design but an actual obstruction. With the rapid increase in the value of land which has taken place in all our large cities in late years, a wild fear lest any inch be wasted has resulted in a compactness of plan that is frequently painful. The housekeeper longs for the roomy closets and ample store-rooms of the old buildings; the fine hall that once formed an imposing and appropriate entrance has given place to the narrow entry through which it is frequently impossible to carry the larger articles of furniture. The same difficulty is experienced in the sharp, frequent turns which characterize so many stairways. Bedrooms are pushed into corners where they seldom have the benefit of pure, free air and the heat of the sun, for no other reason than that space is required for ample reception-rooms and state apartments, which, though used comparatively seldom, are treated as the most important part of the house.

The same indifference to the true ends of building are to be noted in public edifices as well as in private ones. Offices are small and frequently without light. In many churches it is impossible either to see the preacher or to hear him, and some of our public halls are not much better, while, as a crowning touch, the seats are placed so close together as to render them the very acme of discomfort to all but dwarfs. Nor are these structural differences the only ones that call for improvement. There are a multitude of modern contrivances that are yet in an undeveloped state. Questions of drainage, of heating, of artificial light, of elevators, of protection against fire, of ventilation, and the very means of supporting life, are not seldom denied us in structures that astound us by their size and which have cost vast sums. It is not because these things are expensive that they are neglected, nor because they are out of the range of our mechanical powers, but because they are looked upon as adjuncts to the buildings to be taken up at some later time and are then never given the strict attention they require. A draughtsman who has prepared a design that captivates him by its beauty, and seems destined to win a much-desired prize by its mere art superiority over other drawings, is too apt to forget that, after all, he has neglected the consideration of utility; and that on the perfection of the adaptation of the structure to human needs must depend its real value, its true measure of success.

The Great Pyramid of Egypt, which is among the most ancient monuments in the world, has survived for thousands of years because each stone had a definite place, in which it was set with the greatest care. It owes its size and its endurance to a strict attention, on the part of its builders, to small things, and the exercise of an almost limitless patience. It teaches a profound truth, that in architecture no single thing is too unimportant to be treated in the best way; and, though we need not seek to erect buildings whose permanency will be of the type of the Pyramid of Cheops, we can at least apply to our structures the same care for the minor parts, believing that, as the members are, so will the whole be.

Architecture must express the life of any people in order to be successful. It is this which makes former styles so admirable, and it is this element that is so sadly wanting in our own. We must not make our lives conform to our buildings, but our buildings must conform to our lives. They must express not only our culture and our tastes, but the land in which we live and the environment in which we are placed. This can never be accomplished by erecting buildings for their exterior only, and until our architects learn to treat the plan and disposition of the building as the chief part of the structure we can never hope to be rid of the discomfort that makes so much of our daily life unbearable. The Gothic builders achieved success, not because their buildings were beautiful only, but because they filled every natural requirement. It is impossible to delude ourselves with the thought that we are equally successful simply because we happen to live in a house with a Gothic front, but which subjects us to hourly annoyances by the total absence of the conveniences and necessaries of modern daily life.

Botany, said Prof. Marshall Ward, in the British Association, ought to be taught in schools because of the interest which the subject arouses in the mind of a child and the ease with which it can be taught. The study cultivates and stimulates those powers of accurate observation and comparison and conscientious recording of results so much needed by all, and which come naturally to children who are not too much under the bane of a mere instruction system. The value of such teaching is not to be measured by the number and kind of facts remembered, any more than historical knowledge consists of being able to remember the dates of battles and other events. The elements of botany afford to the teacher the cheapest, the cleanest, and the most convenient means of cultivating in young children the power of observation and comparison direct with nature, and afterward teaching them to generalize.

WHAT IS INDIVIDUALISM?

By M. HANDFIELD-JONES, M. D.*

SCIENTIFICALLY considered, individualism is the higher evolution of the atom or unit; viewed from a social standpoint, it is a process of intellectual development by which a man is marked out from his fellows. Individualism implies concentration of thought, tenacity of purpose, and a strong sense of self-reliance. It is the religion of the strong man, the master principle of his whole existence. Of this an old writer says: "As every machine has its mainspring, every animal body its heart, and the whole natural universe its sun, so, amid all the multiplied and intricate movements of our individual and social life, there must be one *master principle*—one all-regulating, all-impelling spring of action. If *this* be wrong, then, however fair and promising to ignorant observers, *all* is wrong. Human life should resemble a well-constructed drama. There may be variety, there may be episodes, but unity of action is indispensable, and all that is not in keeping, so as to swell the interest of the grand catastrophe, should be struck out as incompatible with all sound and wholesome criticism." If we seek a perfect exponent of this grand principle, we find it in the person of the Christus—that divine and human figure which men in all ages and in every clime have loved to contemplate. In him every power and every thought were developed and concentrated on one aim; he clung to the set purpose of his life with a tenacity which has never been rivaled; strong and reliant, he held the truth of his own teachings in the teeth of an opposing world.

The great enemy to individualism is laziness, and those who know anything of human frailties will, I am sure, bear me out when I say that "mental" laziness is far more common and far more difficult to overcome than that of the body. It is so much easier to accept dogmatic teaching, and to shift the responsibility of our views on to others, rather than to concentrate our thoughts and work out the lessons of our own observations; it is much more pleasant to butterfly from theory to theory than to seek truth with patient tenacity: why trouble ourselves to learn self-reliance, when natural indolence protests against the sacrifice? It is easier to imitate than to originate; plagiarism and mimicry are such prominent features in our lives, that their presence might almost be quoted as an argument in favor of our evolution in past ages from simian ancestry. How plausible are the ex-

* From an address On Individualism in its Relation to Medicine, delivered at St. Mary's Hospital Medical School, London, October 1, 1890.

cuses we make for our want of this individualism! We are so dreadfully afraid of being thought bumptious, we are so delightfully humble, we really do not wish to intrude our opinion, and yet all the brightest lights of our profession have been men of strong individualism. Harvey thought for himself, planned by patient investigation his theory of the circulation of the blood, and then, in the face of an opposition which cost him for a time his position, his reputation, and even his practice, dared to assert and stand by those views which we hold now as the fundamental principles of our art. Sir Joseph Lister stood very much alone, when, after deep research and careful experiment, he first promulgated his theory of antiseptic operating and paved the way for fresh and undreamed-of triumphs in the domains of abdominal and cerebral surgery. Ovariotomy had such a fearful death-rate at one time that its performance was held to be almost criminal; yet Sir Spencer Wells came forward, almost unsupported, and taught us that the operation was not only justifiable, but capable of being made the most successful of all the triumphs of surgical skill.

Names such as those I have just referred to may perhaps suggest the thought that individualism is another name for genius. The descriptions of genius have been many; thus Dr. Maudsley says, in his work on the Physiology of the Mind: "He who has what is called *genius* is in harmony with and assimilates the best thought of his own epoch and of preceding epochs, and carries it forward to a higher evolution. An age which lacks that impulse of evolution which the genius embodies is apt to harden in obstructive formula." For myself, however, I will define genius as the highest product of individualism, and I will add that, while few human beings reach genius, no human unit is without his share of individualism. Moreover, the more I study the life of a so-called genius such as Hunter or Newton, Faraday or Darwin, the more I am struck with the enormous amount of work which they contrived to compress into one short life. Longfellow probably had the same thought in his mind when he wrote:

> The heights by great men reached and kept
> Were not attained by sudden flight,
> But they, while their companions slept,
> Were toiling upward in the night.

I have stated that no human unit is without his share of the quality which we are considering; it needs only that he should be true to himself, and develop it. I have supported my argument by examples drawn from the highly educated classes, but I can with equal truth quote men engaged in what are termed the humbler walks of life. It is well known that for many of the great improvements in modern machinery we are indebted to working mechanics, men who, with no advantage save the education of experience, have worked out their individual conceptions and revolutionized the course of an industry. I may be allowed to quote one interesting example. In the days of the old Enfield rifle, a large manufacturing firm in Birmingham used to make the barrels of these rifles for the Government. The process was in the main a simple one, the only difficulty being in securing that the barrel should be absolutely straight and true. To secure this latter point often occupied some time, but it was known that one particular workman had some secret of his own, by which he was enabled to glance down the barrel and say at once whether it was perfectly true or not. The man was often pressed to reveal his secret, but always declined. At last, one day for a drink and some two hundred pounds he sold the mystery. It seems he had noticed the simple fact that, when the tube was absolutely straight, no shadow was formed on looking down it toward the light, but if the slightest deflection existed a shadow was thrown on one or other wall of the barrel. Our argument, then, so far as we have followed it out, has brought us to three principal conclusions. firstly, that every man, whatever his station in life, is endowed with a personal equation of thought; secondly, that he can either simply store the raw material of facts and ideas as they are presented to him by others, or he can digest them and reproduce them stamped with the seal of his own individuality; thirdly, that it rests with ourselves either to be mere echoes of knowledge, or else "living voices" recording our own gleanings of truth for the help of coming generations.

Let us now apply these thoughts to the special region of medical education. In his Moral Philosophy, Prof. Stewart puts down *reverence for great names* as one of the principal hindrances to the spread of real knowledge; I wish he had written "to the acquirement of real knowledge," for I am firmly persuaded that no student has reached the first stage of progress until he has subordinated reverence for great names to a profound respect for his own individual opinion. Pray do not misunderstand me: I am not advocating disrespect for our teachers, but I would rather a student formed an erroneous diagnosis and stuck to it, provided always he could give me his reasons for having formed such a judgment, than that he should accept my dictum as a teacher without challenging me for the grounds on which I ventured to differ from him. A man has made a tremendous stride when he has learned to have the courage of his own convictions.

The directors of the Montsouris Observatory, Paris, have found that the electrical disturbances produced by the passage of railway trains are a factor that has to be taken account of in the record of their observations. Two railroads pass close to the observatory, the trains of each of which produce peculiar and somewhat different effects.

THE "POROROCA," OR BORE, OF THE AMAZON.

By JOHN C. BRANNER,
STATE GEOLOGIST OF ARKANSAS.

I ONCE had an opportunity, while traveling upon the Amazon, to observe some of the effects of a remarkable phenomenon which occurs at the northern mouth of that river in connection with the spring tides. It is known to the Indians and Brazilians as the *pororóca*,* and is, I believe, generally supposed to be caused in the same manner as the "bore" of the Hoogly branch of the Ganges, of the Brahmapootra, and of the Indus.† I regret very much that, like Condamine, who passed through this region in 1740, I could not observe this phenomenon in actual operation; but the gentleman whose guest I was at the time, and upon whose boat I was a passenger, was fairly horrified at my suggesting such a thing, while his boatmen united in a fervent "God forbid that we should ever see the *pororóca!*" and ever afterward doubted my sanity. I give some of the results of my observations, however, as collateral evidence, and in order that those who in the future visit this particular part of the Amazon Valley, concerning which so little is known, may be able to see and establish as far as possible the rate of destruction and building up here being carried on.

I was upon a trip from Macapá—a small town on the northern bank of the Amazon, and about one hundred miles from its mouth—down the river to the ocean, and thence up the Rio Araguarý as far as the last might be navigable. The one inhabited place on the Araguarý is a very small military colony, called the Colonia Militar Pedro Segundo. At Macapá I became acquainted with the then director of this colony, Lieutenant Pedro Alexandrino Tavares, and was invited by him to visit the Araguarý.

The trip from Macapá was by a small sail-boat down the Amazon to the ocean, and thence up the Araguarý. Our departure was so timed that we should reach that part of the region disturbed by the *pororóca* exactly at the time of the month when there would be the least probability of its being met with—that is, at the time of the neap tides. The voyage down the river was in the face of the wind, and it was only five days after leaving

* Pronounced *paw-raw-raw'ca*. This word, which is of Tupý or native Brazilian origin, is the one invariably used by the Brazilians. Father João Tavares says it is probably a frequentative form derived from the Tupý word *opoe*, which means "to break with a noise."

† Similar phenomena, though on a much smaller scale, occur on the Garonne in France, on the Wye, Severn, and Trent in England, and on the following streams in Brazil: Rio Guamá, Capim, and Mojú in the province of Pará, on the Rio Purús in the province of the Amazonas, and on the Mearim in the province of Maranhão.

Macapá that we put into a channel on the island of Porquinhos to wait for the turning of the tide. I had already seen islands said to have been half washed away, and others built up, by the *pororóca;* and I had seen upon the shores the evidences of its destructive power in carrying away forests and cutting away banks; but it was on this island that I was first able to see some of its effects near at hand and at my leisure. After having seen so much, I was only the more anxious to see the *pororóca* itself; but my suggestions in regard to it were answered by an ominous silence on the part of the director, and my requests by additional expressions of horror.

As I shortly afterward met and conversed with a man who had seen the *pororóca*, I can not do better than give his description of it. This man was a soldier in the Brazilian army, and, on the occasion referred to, was going with a few other soldiers from the colony to Macapá in a small open boat. Arriving at the mouth of the Araguarý, they went down with the tide, and anchored just inside the bar which crosses the mouth of this stream, to await the turning of the tide, which would enable them to pass the shallows, and then carry them up the Amazon. Shortly after the tide had stopped running out, they saw something coming toward them from the ocean in a long white line, which grew bigger and whiter as it approached. Then there was a sound like the rumbling of distant thunder, which grew louder and louder as the white line came nearer, until it seemed as if the whole ocean had risen up and was coming, charging and thundering down upon them, boiling over the edge of this pile of water like an endless cataract, from four to seven metres high, that spread out across the whole eastern horizon. This was the *pororóca!* When they saw it coming, the crew became utterly demoralized, and fell to weeping and praying in the bottom of the boat, expecting that it would certainly be dashed to pieces, and they themselves drowned. The pilot, however, had the presence of mind to heave anchor before the wall of waters struck them; and, when it did strike, they were first pitched violently forward, and then lifted, and left rolling and tossing like a cork on the foaming sea it left behind, the boat nearly filled with water. But their trouble was not yet ended; for, before they had emptied the boat, two other such seas came down on them at short intervals, tossing them in the same manner, and finally leaving them within a stone's-throw of the river-bank, where another such wave would have dashed them upon the shore. They had been anchored, before the waves struck them, near the middle of the stream, which at this place is several miles wide.

But no description of this disturbance of the water can impress one so vividly as the signs of devastation seen upon the land. The silent story of the uprooted trees that lie matted and tangled and twisted together upon the shore, sometimes half buried in the sand, as if they were nothing more than so many strings or bits of paper, is deeply impressive. Forests so dense that I do not know how to convey an adequate idea of their density and gloom, are uprooted, torn, and swept away like chaff; and, after the full force of the waves is broken, they sweep on inland, leaving the *débris* with which they were loaded heaped and strewn through the forests, or lodged in the very tree-tops. The most powerful roots of the largest trees can not withstand the *pororóca*, for the ground itself is torn up to great depths in many places, and carried away by the flood to make bars, add to old islands, or build up new ones. Before seeing these evidences of its devastation, I had heard what I considered very extravagant stories of the destructive power of the *pororóca;* but, after seeing them, doubt was no longer possible. The lower or northern ends of the islands of Bailique and Porquinhos seemed to feel the force of the waves at the time of my visit more than any of the other islands on the southeast side of the river, while on the northern side the forest was wrecked and the banks washed out far above Ilha Nova.

The explanation of this phenomenon, as given by Condamine, appears to be the correct one—that is, that it is due to the incoming tide meeting resistance in the form of immense sand-bars in some places and narrow channels in others. So long as the tide advances through a deep ocean, it moves freely and swiftly; but when it passes suddenly from the deep waters of the open ocean to the near-shore shallows, it stumbles upon them, as it were, and the waters are heaped up.*

Most persons who mention the *pororóca* say that it breaks as far up the Amazon as Macapá; and, indeed, the people of Macapá themselves often refer to the rapid cutting away of the river-banks near their city as the work of the *pororóca.* It is true that these banks are being rapidly cut down; and it is even a common thing to see, in this part of the country, the stilted houses—the floors being nearly two metres from the ground—that were originally built one, two, or three hundred feet from the water, gradually encroached upon until they fall into the stream. A portion of the old fort at Macapá was, at the time of my visit, about to fall, on account of the land upon which it was built being washed

* Prof. Hartt attributes the *pororóca* of the Rio Mearim in Maranhão to the form of the channel. It can not be questioned that the form of the channel may modify, and does modify, the force with which the surf strikes the shore; but the single fact of its great violence along the shores between the Araguarý and Cape North, where the whole coast is exposed to the open sea save for the protection offered by shallows, is sufficient to show that form of channel is not its sole cause.

away; but all this is the work of a rapid current, for the surf of the *pororóca* does not reach Macapá. Moreover, there is a marked difference in character between the washing done by the *pororóca* and that done by the ordinary river or tide current. The latter works from below, and, by undermining and softening the bank, causes what is known through the Amazon Valley as *terras cahidas*, or fallen banks. The land falls into the stream in sections of various widths, and not infrequently these form temporary terraces miles in length. These *terras cahidas* are most common and most extensive on the upper Amazon during high water; but they may be seen on a small scale at various places through the valley.* From this it is clear that the work of destruction goes on entirely below the surface. With the *pororóca*, on the contrary, the water is dashed fairly against the banks, the earth is washed away from above as well as from below, and the shore is left clear of loose *débris*. The depth to which the banks are cut shows that this disturbance is also a profound one; so much so, indeed, that on the northwest side of Porquinhos the deepest place in the channel of the river was, in 1881, close to this island, where the action of the *pororóca* was most violent.

Throughout this region of the Araguarý the *pororóca* is largely instrumental in the rapid and marked changes that are constantly going on. The water of the Amazon is notoriously muddy, and, as would naturally be expected, these disturbances in comparatively shallow places make it much more so, and fill it with all the sediment it can possibly carry. Even when I entered the Araguarý, a time when there was the least possible tidal disturbance, the water near the mouth of this stream was so muddy that a thick sediment would settle in the bottom of a vessel of it left standing a single minute; though the water of the Araguarý proper, as far down as the Veados, is of a clear, dark color. But the work of tearing down and that of building up is equally rapid, and the vegetable world takes quick possession of what the sea offers it; and, while some islands are being torn away, others are being built up, old channels being filled, islands joined to the mainland, and promontories built out. To the northwest of Faustinho is an island known as the Ilha Nova (New Island), about ten miles long by about three wide, when I saw it, and which, I was assured by several trustworthy persons, did not exist six years before. In 1881 it was covered by a dense forest. The young plants were sprouting at the water's edge, those behind were a little taller, and so on; so that the vegetation sloped upward and backward to a forest from twenty to thirty metres high in the

* For a good description of the *terras cahidas*, see The Naturalist on the Amazon, by Bates, fifth edition, p. 249.

middle of the island.* On the southern side of the mouth of the Araguarý was a point of land nearly or quite six miles in length, and covered with vegetation, from young shoots to bushes six metres high. I was told that one year before this was nothing more than a sand-bar, without a sign of vegetation on it. The western end of the island of Porquinhos was once known as Ilha Franco; but the channel that separated it from the Porquinhos has been filled up gradually, and the two islands are now one, though the upper end of it is still known as Franco. The point in the mouth of the Araguarý known as the Ilha dos Veados (Deer Island) was, at the time of my visit, fast being joined to the mainland. A couple of years before, boats navigating the Araguary passed through the channel on the south side of the island. In 1881 it was no longer navigable, and the Veados was rapidly being made part of the right bank of the river.

Owing to this shifting of material the pilots never know where to find the entrance to the Araguarý River. One week the channel may be two fathoms deep on the north side, and the next it may be in the middle; or it may have disappeared altogether, leaving the river-bed perfectly flat, with only one fathom of water across the whole mouth. The bar was in this last-mentioned condition when I passed over it in 1881. At this time another bar extended eastward from the eastern end of Bailique, while a little farther out was another just south of the same line. The shifting nature of the sand-bars about the mouth of the Araguarý renders it unsafe for vessels drawing more than one fathom to enter this river, except at high tides; but, as high tides and the *pororóca* come at the same time, only light-draught steamers can enter by waiting well outside the bar until the force of the *pororóca* is spent.†

With the few canoes or small sailing vessels that enter this stream (probably less than half a dozen a year) it is the custom to come down past Bailique with the outgoing tide, and to anchor north of the bar that projects from the southern side of the Araguarý, and there to await the turn of the tide to ascend the latter river. Care is always taken to pass this point when the tides are least perceptible.

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* The plants growing upon this newly formed land are all of one kind. They are called *Ciriúba*, or *Xiriúba*, by the inhabitants, and belong to the family *Verbenaceæ*, genus *Avicennia*.

† Probably the only steamers that have entered the Araguarý have been Brazilian men-of-war of light draught. But in 1881 there was nothing to take a steamer, however small, into this region; for, although the forests below the falls contain an abundance of rubber trees, and although cacao trees form extensive forests, there was at that time next to no population on the stream, while the malaria and the mosquitoes made it almost impossible to live there—indeed, this region is noted for being the most unhealthful on the lower Amazon. Some rubber is gathered above the falls, but it is carried overland from Porto Grande to the Rio Matapý and thence by canoes to Macapá.

Although the *pororóca* breaks as far up the Araguarý as midway between the Veados and the entrance to the Apureminho, its violence seems to be checked by the narrowing of the stream below the Veados, by the turns in the river, and by the vegetation along the banks.

This vegetation is of a kind against which it seems to be least effective—namely, bamboos. They grow next the stream from near the mouth to the foot of the falls above the colony, and for much of the distance form a fringe to the heavy, majestic forest behind them, than which nothing could be more strikingly beautiful. The clusters next the stream droop over till their graceful plumes touch the surface of the water, and, as the plants grow older, they droop lower, until the stream is filled with a yielding mesh of canes. I measured a number of these bamboos, and the longer ones, taken at random, were from twenty to twenty-five metres in length and from seven to ten centimetres in diameter. A more effectual protection against the *pororóca* could hardly be devised.

On Bailique and Brigue I found the forests very different from any I had hitherto seen in the tropics. These islands, like all the others in this part of the country, are flooded at high tide during part of the year, and, as a consequence, they are very like great banks of mud covered with the rankest kind of vegetation. This vegetation varies with the locality. All around the borders the island of Brigue is fringed with tall assai palms, bamboos, and various kinds of tall trees, all of which are hung with a dense drapery of *sipós* (lianes) and vines, which form an almost impenetrable covering. Inside of these are several palms, the most common being the *ubussú* (*Manicaria saccifera*). The next in order are the *murumurú* (*Astrocaryum murumuru*), *urucurý* (*Attelea excelsa*, the nut of which is used for smoking rubber), and *ubim* (*Geonoma*). But, unlike most tropical forests, this one has very little or no undergrowth, except upon the borders. Most of the ground was under from one to six inches of water, while the exposed places were covered with fine sediment deposited by the standing muddy waters of the Amazon. I walked several miles through this forest without finding any palms except the ones mentioned. The little ground above water was covered with the tracks of deer, pacas, cutias, and of many kinds of birds, mostly waders; but the death-like stillness was unbroken, save for the little crabs that climbed vacantly about the fallen palm leaves or fished idly in the mud for a living.

This half-land and half-water condition of the country is common not only in the immediate vicinity of the mouth of the river, but through a very large part of the valley of the Amazon, and is one of the most impressive features of this wonderful region.

But, instead of adding to what has already been written upon this subject, I will quote a few words from two writers, whose descriptions are entirely trustworthy: "All that we hear or read of the extent of the Amazons and its tributaries fails to give an idea of its immensity as a whole. One must float for months upon its surface in order to understand how fully water has the mastery over land along its borders. Its watery labyrinth is rather a fresh-water ocean, cut up and divided by land, than a network of rivers. Indeed, this whole valley is an aquatic, not a terrestrial basin." *

"This belt . . . can not be called either land or sea, island or archipelago. It is a veritable labyrinth of streams, canals, gulfs, islands, and lakes, combined in such a fashion as to impress one as to the caprice of man rather than as the work of Nature." †

This vast expanse of muddy water, bearing out into the ocean immense quantities of sediment; the *pororóca*, breaking so violently on the shores, and carrying away the coarser material to the open sea, and burying uprooted forests beneath newly formed land; the rank vegetation of islands and *varzea* rapidly growing and as rapidly decaying in this most humid of climates; the whole country submerged for a considerable part of the year by the floods of the Amazon—impress one with the probability of such phenomena having been in past ages, and still being, geological agents worthy of study and consideration. Across the mouth of the Amazon, a distance of two hundred miles, and for four hundred miles out at sea, and swept northward by ocean-currents, beds of sandstone and shale are being rapidly deposited from material some of which is transported all the way from the Andes, while in many places dense tropical forests are being slowly buried beneath the fine sediment thrown down by the muddy waters of the great river.

So many random and erroneous statements concerning the *pororóca* have been made by writers upon Brazil that I take this occasion to refer to and correct some of the most glaring of them.

Prof. William H. Edwards, who visited the Amazon region in 1846, has made way with it altogether, and says that "no one knows of such terrible phenomena nowadays," although he "inquired of several persons accustomed to piloting in the main channel, and of others long resident in the city of Pará." But, with the exception of a very few who have business relations in that direction, the people of the city of Pará, as a rule, know as little of the northern mouth of the Amazon as they do of the

* A Journey in Brazil, by Prof. and Mrs. Louis Agassiz, p. 256.

† Major João Martins da Silva Coutinho, in the Bulletin de la Société de Géographie, October, 1867, p. 330.

mouth of the Nile. And no wonder; for the Araguarý region can not be considered an attractive one in any respect, while the relations of the Paraenses with the outside world are all through the Pará River, which is the main channel, and the only one used nowadays by vessels visiting the Amazon, whether stopping at Pará or going farther up the valley.

M. A. de Belmar tells how ships coming up the Amazon to Pará avoid the *pororóca*. Prof. Orton says it rises suddenly along the whole width of the Amazon; while a writer in the Bulletin de la Société de Géographie (November, 1871) says it is washing away the shore at the Salinas lighthouse, southeast of the mouth of the Pará River. In reply to all this I have only to repeat that the *pororóca* proper is confined to the northern mouth of the Amazon, in the vicinity of the Rio Araguarý.

It is well known that the tide is felt as far up the Amazon as Obidos. Mr. Belmar has erroneously attributed this to the *pororóca*. One authority, in describing this phenomenon, represents the waves as breaking upon the rocks. I can say, from personal observation, that there is not a rock to be seen from a short distance below Macapá to near the colony on Araguarý. I can not speak positively of what may be found in the vicinity of Cape North, but I very much doubt there being many rocks exposed there, if any at all.

All that has been written upon this subject by persons having visited the theatre of its action in Brazil is limited to the notes of Condamine on the great *pororóca* of the Amazon and Araguarý,* to those of Bernardino de Souza,† and Dr. Alfred R. Wallace ‡ on the small one of the Rio Guamá. Dr. Marques also gives something regarding its occurrence on the Rio Mearim, in the province of Maranhão.#

So far as I am able to ascertain, the *pororóca* itself in its greatest development has never been seen by a white man.

Mr. Woodford, the traveler, says that, although the natives of the Solomon Islands have matches, they still make fire by friction on certain ceremonial occasions. Their method is to rub a hard piece of wood in a groove formed on a soft piece; but, though the savages would usually produce fire in less than a minute, the traveler himself "rubbed till his elbows and shoulders ached without ever producing more than smoke."

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* Voyage fait dans l'intérieur de l'Amérique, par M. de la Condamine. Paris, 1745, pp. 193–195.

† Lembranças e Curiosidades do Valle do Amazonas, pelo Conego Francisco Bernardino de Souza. Pará, 1873, pp. 126, 127.

‡ The Amazon and Rio Negro, by Alfred R. Wallace, pp. 114 *et seq.*, where it is spoken of as a "*piroróca.*"

Diccionario da Provincia do Maranhão, por Cezar Augusto Marques. Maranhão, 1870, pp. 385, 386.

THE EXPERIENCES OF A DIVER.

By Prof. HERMANN FOL.*

THE Romans of the easy class dreamed of junketing in a villa with an outlook on cultivated fields. A hundred years ago the Alps were never spoken of without laying stress upon their terrors. Such facts show how different are the tastes and the ideals of this generation from those of our ancestors. In the present age of tiresome security, we have become amateurs of danger. One man scales the highest mountain-peaks without any other purpose than to taste for a few hours the rough pleasure of the struggle for existence. Another prefers risks that will contribute to the increase of man's scientific capital, and will leave something more than a simple personal recollection. I invite the exuberant forces of living youth to the exploration of the sea, than which a vaster field and one more capable of satisfying daring and curiosity of every kind can not be found. It is an exploration which, with all deference to cabinet naturalists, presents at once a great attraction and a high scientific importance.

I know persons whose ideal consists in getting preserved specimens, no matter how many, provided they are new. We call new a species that has not yet been dressed up with a Latin name, and which we have consequently a right to baptize with a word in a dead language, followed by the name of the baptizer. The harm of the matter is in the latter element, for, without that addition, the number of Latin names would be reduced by a half, and there would be no occasion to protest against authors who create a genus for each new species. Some find their pleasure in classifying and naming species. Others profess to despise that occupation. They prefer to dissect animals and describe their anatomy, without concerning themselves respecting the use to which the organs are fitted. Still others love to describe the development of beings, without knowing anything of the purpose of the successive organizations of larvæ and young; and they meet in the work anomalies that puzzle their brains. We understand the swallow, because we see its actions. But if there were naturalists living on the bottom of the ocean who had never been in the air, and who knew these graceful birds only through specimens preserved in alcohol, what brilliant zoölogical, anatomical, and embryogenical dissertations would they not make on the subject! I know many among naturalists occupying themselves with marine zoölogy who do not dive or swim, and whose science is of no more value than the swallow-science of our supposed submarine natu-

* Address before the Nautical Club of Nice.

ralists would be. We recognize their excuse. It is, that means of observing marine animals in life, aquariums, and especially the diving-dress, are not within everybody's reach. They cost considerable sums. The student needs a diving-jacket, a boat of considerable tonnage, and a crew of competent men, all to himself and under his orders; for freedom is a great element of success in all scientific investigation.

The diving-jacket is a more ingenious and more useful invention than many that make more noise. It is dangerous or safe according to the way it is used. It has come into extensive use. Every seaport, every war-vessel, and every large steamer has a diving dress and apparatus. Even sponge-fishers have recourse to it. Science, however, could derive no profit from the reports of professional divers; their veracity is below everything that could be imagined, and then they look without seeing. Although inhabited by millions of negroes, Africa remained unknown till educated white men succeeded in crossing it; the bottom of the sea will never be known till good observers have gone down there.

Students should descend themselves; but, unfortunately for science, persons are rare who have gone to see in place the animals concerning which they have written large books. They might have been spared many errors. Some have not the means; others are afraid; and still others have once gone down two or three metres, and then hurried to fill the press with the creations of their imagination; for the first plunge which one makes is of no value for the observation of things that are outside of himself. He sees thirty-six colors, and that is all.

This first plunge leaves no agreeable memories. They dress you as if you had to endure the cold of Siberia, a precaution which I have found useless in the Mediterranean. With knit woolen hose, cap, and shirt, I have never felt the cold. Then comes the ample coat, which we get into through the neck-hole, and the casque, which resounds as if one had his head in a kettle. Then they put on you a belt with a dagger, shoes with leaded soles, and lead at your breast and back. Now you are so loaded that you could hardly stand straight if the boat should tip—then you go down into the water where all the weight is no longer felt.

Now a different feeling begins. At the command, "Pump!" some one rapidly screws down the glass in front of your casque, and you hear a noise to which you have to accustom yourself—*pah! pah! pah!*—accompanied by a hissing of the air. Little whiffs of air come to you, scented with machine oil and caoutchouc. The beginner fails to manage the escape, and his coat and sleeves become inflated, so that, when he wants to go down, he floats like those frogs we used to blow up when we were boys, and then throw upon the water to amuse ourselves with their vain struggles to get under it.

Then comes the gurgling of the water and air escaping through the valve, and you descend. The pressure immediately increases at the rate of one atmosphere for about every ten metres of depth. This increased pressure, which would be insupportable if it was unequally distributed, is hardly felt, because it is exerted in every direction. The air is reduced to half its former volume, so that our inspirations take in double the usual quantity. Instead of breathing more easily, as one would naturally suppose he would do, the diver feels an oppression which is very troublesome at first. But it soon passes away. It is caused by a pressure on the alveoli of the lungs which impedes the exchange of gases. But the equilibrium is soon restored spontaneously.

The most disagreeable sensation produced by the descent consists of pains in the ears, sharp and accompanied by a feeling of dizziness. It is caused by a pressure of the air contained in the medial ear; the tympanum is stretched and pushed upon the ossicles, till a bubble succeeds in making a passage for itself through the Eustachian tube. The pain then ceases, but returns as the descent is continued. After a few plunges, the Eustachian tube enlarges enough to let the air pass freely, and the pains cease. The dizziness is explained by the fact that the inner ear, as M. Delage and other physiologists have shown, is the seat of the sense of direction; so the novice does not know where he is, and imagines that his head is down. Mariners, in training for diving, are caused to go down first in a spot where there is hardly water enough to cover the casque; they come back with downcast features and the flurried air of a man afflicted with vertigo.

The most delicate point is the regulation of the air-escape. The novice lets out too much air, and water comes in by the valve, and the casque seems so heavy that he imagines he is nailed to the bottom. He then lets too much air accumulate, his coat swells, and the casque rises so much as to take the valve out of reach of the hand. Despite all his efforts to stay on the bottom, he springs up to the surface. The air, released from the pressure, expands, the coat is inflated almost to bursting, and he floats like a dead body. One can never be a good diver till he learns to regulate the air as a horseman holds the reins—without thinking about it. We might, indeed, adjust the valve for a particular depth, so that it shall act automatically; but the diver who desires to ascend and descend at will, will do better to keep the escape-valve taut, and regulate it with his head.

The beginner is not able to travel about as he wants to—first, because he feels too light or too heavy, according to the quantity of air in his coat; and, second, because the water offers an unexpected resistance to his progress. He sees things two steps away that he wants to get, and can not reach them.

Pictures show the diver walking along on the bottom of the sea as he would do on the land; it is a false representation. One can not get along without bending his whole body at an angle of forty-five degrees in the direction he wishes to go, and then pushing along on tip-toe in an attitude that would excite laughter in a beholder, assisting himself with his arms as in swimming. If the bottom is uneven, he will do better to creep on his hands and knees.

On the other hand, one can do things in the water that are impossible in the air—let himself drop, for example, from the rocks; the water will break the fall. Or, he can climb cliffs by letting a little air collect in his coat and planting the ends of his fingers in the cracks and rough places. On broken ground he can pass with a kind of flying leap from one rock to another. But all this supposes a degree of familiarity which is not acquired for a considerable time. In my first efforts I cut my hands terribly, and was not able to use my pen or pencil for several days. I tried a coat made with the sleeves ending in India-rubber gloves, but they prevented my picking up small things, and, moreover, did not last long. I then returned to the common sleeves, closed at the wrist, and used knit woolen gloves.

Another difficulty is occasioned by the glasses of the casque becoming covered with the vapor that results from the condensation of the moisture of the breath. The colder the water, the thicker the vapor is. No means as yet tried to get rid of it have resulted satisfactorily, but I have solved the problem by rubbing the glasses with glycerin. The mist then condenses in a uniform nap which does not obscure the glass.

When all these difficulties have been surmounted, there is still one that persists—that is, the effect and the danger of compression and decompression. That imposes a limit to the depth a man can reach with the diving-dress. Divers are liable to two kinds of accidents. One is a prostration on coming to the surface, for which restorative measures often have to be applied; and which, according to Paul Bert, results from the effects of the change of medium on the spinal marrow. It is rarely mortal, but may eventually produce a paralysis of the lower limbs. The other accident, graver but very rare, consists of a gaseous embolism of the capillaries of the lung, produced by the disengagement of bubbles of air in the blood, which has dissolved too much of it while under high pressure. The action is like that of Seltzer water at the moment of pressing on the pedal of the siphon. Under its effects, when it occurs, the diver dies as soon as he reaches the surface.

Both causes of accident can be avoided by descending and rising slowly. For this reason a steel chain may be used as a ladder, to be let down to the depth the diver has reached, by the aid of which he can stop at will while coming up. But the question of time comes in to limit the depth which it is possible to reach. If we allow three quarters of an hour for a diving excursion, a quarter of an hour will be required to descend below thirty metres, and as long to come up; so that only a quarter of an hour is left for staying on the bottom.

Of the scientific observations which I have been able to make with the diving-dress, I will speak only of those of a physical order; a book would not be sufficient to describe my zoölogical observations. When the water is transparent and the sun shining, we can, looking down from the boat, distinguish the bottom to about twenty metres; but for that the surface should be perfectly smooth. I have had fixed in the bottom of my yacht Amphiastre a light-port with a very thick glass. By darkening the cabin we can see through it clearly, farther than twenty metres, even when the surface of the sea is troubled. Seen thus from above, the bottom of the sea always looks flat. All the visible parts are equally lighted, and the appearance of relief is naturally destroyed by the absence of projected shadows. In going down in the diving apparatus, we are astonished at perceiving that the ground, which appeared nearly uniform, is really bristling with rocks and hollowed by deep valleys. The shadows are now visible, because the light coming from above, the parts under the projections of the rocks and the tufts of sea-weed are in the dark. If the diver looks up from the bottom through the frontal glass of his casque, he will see a great light, circular space that may be regarded as the base of an inverted luminous cone, of which the spectator's eye occupies the tip, and the apical angle of which is about 62° 50′. Beyond this circle the surface looks dark, presenting precisely the aspect of the sea as seen when looking down into it from the boat. The sky and objects in the air are visible only within the limits of the luminous circle. The borders of this circle are always more or less indented, for the surface is never perfectly quiet. The sunbeams are dimmed and come down in dancing showers as we see them in a room on the edge of the water when the blinds are drawn down, and the rays, reflected from the mobile surface, shine upon the ceiling of the room.

The decrease of density of the sun's rays is very rapid, and they are almost completely diffused at thirty metres. As the sun declines toward the horizon, a darkness suddenly comes on which has sometimes caused me to ascend very speedily, in the belief that night had fallen. Coming out of the water, I was astonished to find myself immersed in the rays of a sun not yet near setting.

There is an angle at which the proportion of rays reflected to rays refracted becomes so much against the latter that the illumination of the bottom falls off very abruptly.

The transparency of the water along the littoral varies enormously. In times of rain, it is clouded by swollen streams pouring into it; in dry and still weather it becomes nearly as clear as in the open sea. There are also capricious and sudden changes caused by currents from the land or from the open sea, which are capable of producing great effects in a few hours. Experiments on the penetration of light, to have any value, should be made very far out.

When the water is comparatively clear, it still absorbs so much light that at thirty metres' depth, if the sky is clouded, one can not see distinctly enough to collect small animals. In a horizontal direction one can not distinguish a rock more than seven or eight metres off. When the sun is shining and the water is very clear, we can see a bright object at twenty or even perhaps at twenty-five metres. But in usual conditions we have to content ourselves with half these numbers. These facts, verified many times in the descents which I have executed with the diving apparatus of my laboratory at Nice during the last three years, appear to me important from several points of view.

It is evident that a submarine boat can not see its way under these conditions. Slow as may be its movement, there will not be time for it to retreat if it sees some obstacle rising in front of it; for it would not be more than ten metres away from the impediment at the moment of perceiving it. It will always have to take its directions before going down, and to sail only upon a ground the relief of which has been carefully explored. Submarine navigation will thus always be confined to limits which the genius of man—since it can not change the transparency of water—will never be able to enlarge.

These observations are also of great interest from a biological point of view. We can see every day that agile marine animals living in the illuminated strata of the waters—fishes, lobsters, and cephalopods—are in the habit, when they are frightened, of giving themselves up to a very rapid flight and quickly stopping. They feel that a few metres are enough to put them out of the range of vision of their pursuer. Some even take the pains to add to the obscurity of the water by discharging their ink, as the squids do, or stirring up the mud, after the manner of many fishes. Marine animals may well be near-sighted; for of what use to them is a long vision when they can at most see only a few metres away? Hence their crystalline lens is bulged into a nearly spherical shape. They live in a world of surprises, and, as it were, in a perpetual fog. The nets we stretch for them would hardly take any fish, at least in the daytime, if they could see as far as we see in the air.

The color of water varies from blue to greenish, usually according to the degree of its clearness. Objects at twenty metres' depth begin to take a bluish hue, and at from twenty-five to thirty metres the light is so blue that dark-red animals look black, while green and bluish sea-weeds seem almost white by contrast. Coming back quickly into the air, eyes accustomed to the blue light see the air-landscape red. The red rays are extinguished first, a fact which had been already demonstrated by laboratory experiments. The blue rays, being absorbed in a less degree, penetrate farther; and these are the rays which act most energetically on the photographic plate. This fact disposes of the objections which some students have repeated with a persistency that is not creditable to their ideas of physics, against the use of photographic plates in determining the depth to which daylight can penetrate through water.

When there is a swell, the diver's task is a hard one. He is constantly tossed about in spite of himself, and an irresistible force compels him to swing like a pendulum. This oscillation of the water, which is a counterpart of the waves of the surface, is nearly as perceptible at thirty metres as at ten metres. It can not be a surf phenomenon, for fishermen find that, after a storm, depths of fifty metres and more are swept by it. Special apparatus and experiments are required to determine to what depth it extends; but, in view of the incompressibility of water, I should not be astonished to find it extending very far down. In this matter, as well as in a great many others, the diver is in a condition to gain valuable information by which new avenues may be opened for the study of the phenomena of Nature.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

DRESS AND PHYSIQUE OF THE POINT-BARROW ESKIMOS.

By JOHN MURDOCH.

THE people who live on the extreme northwest corner of our continent are far from being an ugly or an ill-made race. Though they are not tall—a man of five feet ten inches is a tall man among them—they are well-proportioned, broad-shouldered, and deep-chested. The men, as a rule, are particularly well "set up," like well-drilled soldiers, and walk and stand with a great deal of grace and dignity. I fancy that a good deal of the erect carriage of the men comes from their habit of carrying the gun, or in old times the bow, in a case slung across the back, by a string passing round the chest.

The women do not have such good figures, but are inclined to slouchiness, which they perhaps get from trotting ahead of the dogs when traveling with sledges. They are seldom inclined to be fleshy, though their plump, round faces, along with their thick fur clothing, often give them the appearance of being fat. They generally have round, full faces, with rather high cheek-bones, small, rounded noses, full lips, and small chins. Still, you now and then see a person with an oval face and aquiline nose. Many of the men are very good-looking, and some of the young women are exceedingly pretty. Their complexion is a dark brunette, often with a good deal of bright color on the cheeks and especially on the lips. They sunburn very much, especially in the spring, when the glare of the sun is reflected from the snow. They have black or dark-brown eyes and abundant black hair. The women's hair is often long and silky. When they are young they have white and regular teeth, but these are worn down to stumps before middle life is reached. Cheerful and merry faces are the rule, and they are altogether pleasant people to see and to associate with. The men cut their hair square across the forehead and comb it down into a regular "straight bang," with long locks on each side of the head, covering the ears, but clip a round spot on the crown of the head like a monk's tonsure, and a strip about two inches wide from this tonsure down the back of the head to the nape of the neck. They say that, unless the hair is clipped off on the crown and back of the head, the man will suffer from snow-blindness in the spring. The women part their long hair smoothly down the middle from the forehead to the back of the neck, and gather it into a braid on each side behind the ear. When they are dressed up, these braids are wound round and round with a long string of small, bright-colored beads, and the whole finished off with a flat brass button fastened into the hair behind each ear. They wear ear-rings, too, usually made of long glass beads, dangling from a little ivory hook which fits into the hole in the ear. They are all tattooed with one, three, or five narrow blue lines running from the under lip to the chin. The men are seldom tattooed, but instead, they wear the curious *labrets*, or lip-studs, which are peculiar to the Eskimos of the Northwest. These are large studs of stone or bone, like sleeve-buttons, which are buttoned into holes in the under lip, one at each corner of the mouth. At first sight, these ornaments appear a hideous disfigurement, but it is surprising how quickly one gets used to them. The most fashionable labrets, which are worn on "swell" occasions, are made of white marble in the form of flat disks, about an inch and a half in diameter, with half a large blue-glass bead glued to the middle of each. Others are shaped like plugs, and are made of black, white, or gray stone. They used to pick up the stoppers of Worcestershire-sauce bottles that we threw away, and make labrets of them. All they had to do was to grind off the knob on top a little, to make it fit comfortably between the lip and gum.

Their clothes are made almost wholly of the skins of wild animals, though they sometimes wear outside frocks of calico or drilling. The skin which is most commonly used is that of the reindeer, which is perhaps the best material that could be found for clothing in a cold climate. It is very warm and at the same time very light, and can be had of various thicknesses, from the short-haired fawn-skin, fit for making handsome thin clothing, to the heavy winter coat of the buck, suitable for blankets or thick clothing, to wear in the very coldest weather.

A man's full suit of clothes consists of a loose frock, with no opening except at the neck, provided with a hood that can be drawn up over the head, and a pair of close-fitting knee-breeches, tied down with draw-strings over the tops of the long boots. In cold weather a second frock is worn under the first, with the hair side next the skin, and an extra pair of breeches. On the feet are worn long stockings of thick deer-skin, with the hair next the skin, and outside of these the tight-fitting boots, which in winter are made of the short-haired skin of the deer's legs, with soles of sealskin tanned white, and in summer of water-proof sealskin, with the hair carefully scraped off without removing the black epidermis, with soles made of the skin of the bearded seal or the white whale. These boot-soles are very neatly crimped up all round the foot, like the soles of moccasins. The crimping is done with the teeth, which is one reason why the women's teeth wear out so quickly.

I know of no warmer and more comfortable foot-gear for a cold climate than the Eskimo fur stocking and deerskin boot, with the elastic pad of whalebone shavings worn under the foot, between the stocking and the boot as they wear it.

The man's frock is cut off square across the skirts, and reaches about to the middle of the thigh. The women wear a good deal longer frock, which comes down in two rounded flaps, one in front and one behind, nearly or quite to the knees. This frock, too, is made looser in the back than the man's, so as to make room for the mother to carry her little baby inside, and there is a special bulge in the hood just at the back of the neck to make room for the youngster's head. Instead of breeches and boots, the woman wears tight-fitting pantaloons all in one piece with the shoes, which have soles like those of the men's boots. These pantaloons are made of deer-skin in winter, but in summer they are made of the same stuff as the men's water-proof boots. The men sometimes wear pantaloons like the women, and the boys all do till they arrive at manhood and have their lips pierced for the labrets. The boys wear jackets like the men's, but the little girls' dress is a perfect miniature of the women's, even to the pocket at the back of the neck for the baby's head. Indeed, the larger girls sometimes do duty as nurses, and carry round their little sisters in their jackets like grown women.

The usual material for jackets is reindeer-skin, prepared without any process of tanning. The skin is first dried in the sun, and then the stiff under membrane is carefully scraped off with a very effective tool made of a small piece of flint chipped into a blunt blade, and fitted into a handle of ivory or wood, shaped so as to fit exactly into the hollow of the hand. This scraping also serves to soften the skin, just as you soften a sheet of stiff paper by rubbing it up, and the skin is finally finished off by rubbing it with pumice-stone and gypsum or chalk. When the skin is finished the inside looks and feels like white wash-leather, but, of course, is easily spoiled by wetting. All sorts of skins that are to be used with the hair on are dressed in this way.

To make a frock of ordinary thickness, they usually select the skins of does in their summer coat, one for the front and one for the back, and put them together so that the best part of the skin, on the back of the animal, comes on the front and back of the person where it will show, while the poorer skin from the belly is concealed under the arms or the sides. The head of one skin is made into the hood by fitting it in with seams. All these garments are made on regular patterns, just as our clothes are; all jackets, for instance, having practically the same number of pieces. To make the frock fit round the neck, there is a curved triangular piece let in on each side of the throat, and these throat-pieces are always made of the white skin from the belly of the deer, no matter what is the color of the rest of the garment. This gives a very pretty effect to the frock.

Heavy frocks for very cold weather, especially for wear when out on the ice seal-hunting, are made of skins of deer in the thick gray winter coat. Now and then you see a frock made of the Alaskan variety of the mountain sheep, which is of a pale buff color, almost white. Full-dress frocks are also made of the white or variegated white and brown skins of the tame Siberian reindeer, which they get by trading from the Eskimos whom they meet in the summer at the mouth of the Colville River. The latter get them from Kotzebue Sound, whither they are brought from Asia across Bering Strait. These skins are highly prized.

There was one old fellow at Cape Smyth who was a very great dandy. He owned, among other fine clothes, two very "swell" frocks, one made wholly of ermine-skins put together in stripes of brown summer skins and white winter skins alternately, with the tails and feet dangling, and another of blue and white fox-skins put together in alternate stripes.

The every-day frock has very little trimming except a fringe of wolverine fur around the wrist, and a strip of long-haired wolf-skin round the edge of the hood, so that, when the hood is drawn up over the head, the long hair stands out all round the face like a halo. This is not merely an ornament, but also serves to protect the face against the wind. Working frocks are often without even this frill. Full-dress jackets are often very prettily trimmed with edging made of alternate strips of light and dark skins, fringed with wolverine fur, and often ornamented with little knots of red worsted.

The breeches are usually made of heavier deer-skin than the frock, so that only one pair is more often worn than a single frock, and then with the hair inside. Full-dress breeches are tastefully trimmed with edging like the jacket. The boots and the women's pantaloons, as I have said, are generally made of the skin of the deer's legs, and it is the fashion to have the white patch from the inside of the deer's leg always on the outside of the ankle. A specially fashionable style of boot has the leg made of alternate stripes of white and brown skin, with a very pretty effect. Women's pantaloons also are often made this way below the knee.

Eskimo dandies, instead of having their boots kept up by the draw-strings of their breeches, have the tops finished off with a fancy edging, and kept up by draw-strings of their own. To keep the moccasin-like sole of the boot from getting out of shape and running over on one side, there is a pair of strings fastened to the edge of the sole near the heel, crossed over the instep, and tied round the ankle.

There are several kinds of material used for making boot-soles, and each is supposed to be specially suited for some particular purpose. For walking on dry snow, the best boot-soles are made of sealskin which has been rolled up and allowed to "heat" and ferment a little before drying, so that the epidermis can be scraped off with the hair. This looks like cream-colored morocco and will not stand the least wetting. For walking on the rough sea-ice they prefer to have soles made of sealskin dressed with the hair on, and worn with the flesh-side out; but for their water-proof boots they use the thicker skin of the great bearded seal, or, if they can get it, of the white whale, dressed with oil. Sometimes the skin of the polar bear is made into water-proof soles. The white whale skin is the best material. It makes a translucent, honey-yellow leather, about an eighth of an inch thick, stands the water very well, and is quite durable.

Under the outer pantaloons the women wear a second pair of thicker deer-skin, skin-side out, with stocking-feet. When the spring comes, and the snow gets sloppy on the surface, they discard the outer pantaloons and put on water-proof boots like the men's, but held up by a draw-string just below the knee. Later in the season, when there is a good deal of wet weather, and they are knocking around in boats, they wear pantaloons made wholly of water-proof black sealskin. All these pantaloons, like the men's breeches, are rather short in the waist, and are held up by a girdle just above the hips. Like a sailor's trousers, they need a good deal of hitching up.

The frock is always confined round the waist by a girdle, often merely a strip of skin. The men, however, often have handsome belts about an inch and a half wide, woven of the shafts of feathers. By using black and white feathers a very neat pattern is produced. The fashionable ladies' belt is made by sewing together bits of fur from the feet of the wolverine, each with a single claw attached.

Fastened to the belt behind, every man and boy wears the bushy tail of some animal. A wolverine's tail is the "correct thing"; but those who can not afford this wear the tail of the wolf or the Eskimo dog. This fashion gave rise to the story, told by the old Russian voyagers, of men *with tails* on the American coast.

It is also very fashionable to wear the skin of an ermine dangling from the frock between the shoulders, or an eagle's feather in the same place or on the back of the hood. These are amulets, and are supposed to bring good luck, like the dried birds' heads, bear's claws, and other such things which the men wear dangling from the belt.

The only head-covering is the hood of the frock, which comes forward just far enough to cover the ears. In very cold weather, or when they are sitting on the ice watching for seals, the men wear cloaks of deer-skin over their other clothes. When it rains, or when they are out in the boats in rough weather, both men and women draw over their other clothes a frock made of strips of the entrails of the seal dried and stitched together. This frock has a hood which fits close round the face, and is quite water-proof.

Since these people have had so much to do with the white men, they have taken to wearing a good deal of bright-colored calico. Of this they make long frocks without hoods, which they wear over their furs in blustering weather to keep the snow from getting on to them.

Of course, in such a climate, the hands need to be well protected, and they have first-rate gloves and mittens. The gloves are always made of dressed deer-skin, with the hair-side in, and usually have a fringe of wolverine fur round the wrists. They are specially meant for dress occasions, and are often tastefully ornamented. The common, every-day mittens are made of thick deer-skin, and are always worn with the hair next the hand. Both men and women, particularly the women, when they have no work to do that requires both hands, have a great habit of wearing only one mitten, and drawing the other hand back through the sleeve inside the jacket for warmth.

In very cold weather, particularly when hunting or traveling, they wear very thick mittens made of the shaggy hide of the polar bear. These keep the hands very warm, and one of these mittens held upon the windward side of the face makes a capital screen against the sharp wind. The long, harsh hair, too, makes a first-rate brush for dusting off frost and snow from the clothes, and for brushing up the floor. When hunting with the rifle in winter, the hunter wears a pair of thin deer-skin gloves under his mittens. Then, when he is ready for a shot, he slips off his clumsy mittens, and can handle his gun without burning his fingers on the cold iron.

Of course, all these clothes are made by the women, who cut them out by their eye very skillfully, using their favorite tool, a broad knife shaped like a chopping-knife, which they use for cutting everything, from their food to a thread. This is better than scissors for cutting furs, because in cutting from the skin-side you cut the skin without cutting the hair.

For sewing skins they make their own thread by stripping fibers from a piece of dried sinew, but use nowadays steel needles and common brass thimbles. They do not sew as a white woman does, but wear the thimble on the forefinger and thrust the needle through from left to right. In old times their needles were made from the small bones of the reindeer's legs, and they used thimbles made of a bit of sealskin, in the shape of a ring with a pad on one side to press against the needle.

The great time for making new clothes is in October and November, which are named in the Eskimo calendar "the time for sewing" and the "second time for sewing." All summer long they have been living in tents and knocking round outdoors, and their clothes have grown pretty shabby and dirty. Now they have come back for the winter, and the time has come to make new clothes. But deer-skin clothes must not be made in the village while the hunters are out after seals, for that would bring bad luck; so the women take their work out into little tents pitched some distance from the houses.

By the time December comes, and with it the season for the winter festivals, everybody in the village has his new clothes for the year, and all look neat and trim in fresh brown deer-skins and clean white mittens and breeches.

PRAIRIE FLOWERS OF LATE AUTUMN.

By BYRON D. HALSTED,

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IT is not easy to satisfactorily decide why some plants bloom in autumn, while others produce their flowers only in spring. To have hepaticas in April is as much a matter of common expectation as for August to bring the first golden-rods and October a gorgeous display of asters. An unwritten law of Nature has been conformed to, and the result is a floral time-piece of the seasons, so accurate in its wonderful mechanism that one only needs to see the bouquet of a school-girl returning from her Saturday afternoon ramble in the woods to know the month of the passing year. Some time ago (The Popular Science Monthly, May, 1887) the writer prepared a paper upon "Prairie Flowers of Early Spring," in which it was stated that the first blossoms of the season gained an advantage by being first. There is a mutual adaptation existing between flowers and insects that the most casual observer can not gainsay. It is not only an advantage, but in many cases a positive necessity, that flowers be visited by insects in order to secure that transfer of pollen from one blossom to another which results in fertilization. The modern accepted view of all floral display is that it serves the purpose of attracting insects, and acts as a contrivance by means of which the fertilization of a flower by its own pollen is prevented. Botanists of earlier days did not force this truth upon the attention of others, and many persons better qualified to judge of human than natural history arrived at the erroneous, if not somewhat selfish, conclusion that floral forms and colors were primarily to beautify the earth and render it a pleasant habitation for man. No one can for a moment doubt that flowers are beautiful, but beauty is a secondary matter so far as the gratifying of man's taste for beauty in forms and colors is concerned. It is so planned that the qualities which render the floral structures so well adapted to the peculiarities of the insects are the ones which at the same time render them beautiful and thereby contribute to the pleasure of man. In this adjustment we may see the working of an Infinite Mind able to combine the two elements of utility and beauty so completely that it is not extravagant to say they are often inseparable.

In the present paper the reader's attention is invited to some of the plants that continue to bloom after the fingers of Jack Frost have silently pulled down the dark curtain of the waning autumn and shut out the warmth of vitality from all the tender sorts of vegetation. The first day of October opened upon a landscape of varied hues, some of a most somber character, for late in September the leaves of the box-elder, for example, had been blasted by freezing and the vineyards were prematurely brown with the curled and dying foliage rustling in the breeze. Corn and other plants of a like subtropical nature, not previously harvested, were stricken lifeless by the low temperature, and house plants carelessly left out of doors melted away into a mass of rapid decay. As one looked about him the scene could but remind the observer of the Scripture injunction concerning the two women grinding at the mill. Two plants side by side had been growing with equal vigor, and both bespoke an equally long life, but one was taken and the other left. The reason for this is not easy to find.

Many mysteries flood the mind in contemplating the world of vegetable life, but none more thoroughly baffles the keenest observer as well as the most penetrating microscopist than that of hardiness. We freely use the word in ignorance, or worse, to conceal our ignorance, as physicians may employ longer terms among their admiring, awe-struck, ignorant patients, but when the thoughtful pause comes it brings us face to face with a half-clothed skeleton that nearly frightens all save the brazen-faced. We may attempt to explain the real meaning of hardiness in a dozen ways, and in the very offering of so many reasons we exhibit the weakness of all the arguments. If we say that it is due to denser structure, the statement is met with the bald-faced fact that the hardiest plants do not have necessarily the denser tissues. A box-elder, which is considered a type of hardiness, yields a wood less than half as heavy as the hickory. Of the sixteen sorts of trees in the United States with wood heavier than water, all are in the warmer portions of the country, where no winter tests their hold upon vitality. Perhaps it is as much the plan of one species to have its twigs killed back as it is for another to withstand the sudden changes of temperature and the severe cold. It demands a more than human penetration to decide that the horse-chestnut, with its large and well-protected terminal buds in autumn, is better adapted to its conditions than the raspberry, with young, immature wood and imperfect buds, which die before the spring-time comes. The two are working out the problem of existence along widely diverging lines. The tree grows slowly and builds for a century, while the bramble forms only transient stems and runs its chances of making all it can out of a favorable growing season. No one would care to say that a Rubus is less hardy than an Æsculus. They are not to be compared, and there the matter ends. If two species in the same genus have similar habits of growth, and one fails to bear the surrounding conditions while the other thrives, the case is very different, and it is more natural to seek the reason, for the answer, if it could be given, might be a blessing to every orchardist and gardener suffering from losses among his tender plants. And even here it may be that the explanation turns upon surroundings to which each plant has been subjected. We know that species migrate from the home of the parent as birds from the parental nest or the sheep from the fold. It is not difficult to believe that offspring from common stock in time develop progeny subjected to very unlike conditions. Under dissimilar circumstances they develop unlike tendencies; and when, after centuries, these new forms are again brought together through man's culture, while they may be outwardly the same, the one is tender while the other is not. It is a question of the resistive power which, whenever we reach for it, whether with the high-power lens or the chemist's test-tube, the result is much the same. This generation seeks after a sign, and it might do many worse things. It may be a long time before there will be a better test for hardiness than that which is applied when a plant is subjected to the actual conditions. At present there is no rule without innumerable exceptions, which not only "prove the rule," but prove that it is valueless. The Greenlander may easily fall a victim to smallpox, because, we say, his system has not been so situated as to develop the resistive power to this direful malady. The Northern man goes south and is stricken with a fever that does not cause death to those "to the manor born."

In the field we see the corn falls with the first hard frost, while the asters along the roadway hold their freshness and continue to blossom until early winter congeals the sap. Turn to the flower-garden, and we see many of our tender plants in the withered brownness of death, and by their side stands the Anterrhinum in the beauty of its pristine freshness, bearing its blossoms of every size from the minutest bud up to the full flower. The pelargonium has its dead branches intermingled with the living stems of the petunia. The moss-rose is lifeless upon the ground, while the prostrate verbena is fragrant with new blossoms. Snows come and go long after the Indian summer has been succeeded by the chill November days, and the pansies smile from among frosty fallen leaves. Death and life are closely associated, and, while we can not comprehend it all, there are few who would lose the exhilaration of a prolonged search for the sake of knowing it all at once.

Along my daily pathway have thronged the shepherd's-purse and the purslane. The former passed the winter as seedlings from self-sowed seed in early autumn, and closely hugged the frozen soil unprotected, or perchance benignly covered with a blanket of snow. When the November blasts are howling and whirling down the snows, some belated plants—or, more properly, some hasty specimens ahead of their time—are left blooming alone. The pepper-grass (*Lepidium virginicum*) is closely related to the shepherd's-purse, and has the same times and seasons and habits of growth. On the other hand, the hot-blooded purslane, which was able to sprawl at full length upon the superheated ground in August, and thrive, to the great annoyance of the tidy gardener, falls a lifeless victim at the first firm grasp of the frost-king. In its obeseness it blackens with the rising sun, and soon leaves little else behind except the thousands of almost microscopic seeds, for which the icy winter only seems to serve as a fitting introduction to new activities when the long-delaying spring arrives. Look into the vegetable garden, if you please, and recall the two classes of plants therein grown for the table. There are sorts, the seeds of which may be sown as soon as the ground can be worked; while other seeds are of the tender sort and can not be committed to the earth until the settled weather has come and the danger of the laggard frosts is past. Toward the end of the season there is a like distinction. In short, some of the garden favorites must make all their growth during warm weather, and perish with the frosts of autumn; while others can be gathered at pleasure, even left in the earth until the following spring, and improved by the seeming neglect. Of meadow and pasture crops there are few that flower later than the red clover. This may be found in full bloom until the snows cover the melliferous heads for the balance of the year. The alsike also is a late bloomer, but the white sort gives up much earlier.

Let us turn now to the wild plants which are in flower upon or after the first of October in the climate of central Iowa—a prairie region—where autumn is more than past its middle by that date. At the outset, it is manifest of the plants in flower that a large number belong to the sunflower family. Among the most conspicuous are the asters and golden-rods, and the most beautiful of them all is the *Aster Novæ Angliæ*. This is a common species, and because at home in New England—as the name indicates—is none the less attractive, and one, the charm of whose purple rays of the large heads never flags. I have been upon long tramps through the low meadow-land where this species is the chief blossom, and never tired of the variability which the many plants exhibit. The leaves are clasping as if a strong affection existed between the blade and the stem from which it sprang.

Intermixed with this most richly attired of all the asters is the Riddell golden-rod (*Solidago Riddellii*); quite different from all the other Solidagos in having the stems clothed with long, smooth, narrow leaves, which gradually curve upward and then describe a half circle downward. The large clusters of flowers in the medium-sized heads have a depth of auriferous color which can not fail to attract all lovers of yellow. The golden-rod most nearly like the above is *Solidago rigida*, an earlier bloomer but holds its own against the early frosts. As the name suggests, the stem is large and stiff or rigid, the leaves are sessile, large, thick, and the heads of the blossoms form a broad, flat-topped inflorescence, standing three or more feet from the high, dry prairie soil. Among the other golden-rods were *Solidago speciosa* and the altogether common and yet far from the least attractive species, *Solidago canadensis*. This furnishes a serious puzzle to the careless student, but the lover of slight differences in plants finds in this species with its various varieties a subject of absorbing interest. *Aster longifolia* and *A. multiflorus* vie with each other in making the waste places bright and attractive during the October days, and exhibit their powers to resist the destructive agencies of the closing days of autumn by shaking their leafy stems and bright fresh heads of blossoms in the storms of bleak November. The three asters already named are among the last of all the prairie flowers, and seem to be full of life when the streams are icy in the morning and the sunny side of a log is a favorite haunt of the birds of winter.

Along the small brooks and over the lowland, where the fog damp and chill settle at early sunset, the great sunflower (*Helianthus grosse-serratus*) may wave its head, while around it is the retirement of the winter condition. *Helenium autumnale*, with its handsome heads, with lemon-yellow notched ray flowers and peculiar velvety decurrent leaves, is not common but attractive. We do not wonder that it lingers in the lap of early winter, because the atmosphere of its whole being is one of endurance, but of the quiet sort befitting the Quaker and not that of the bully.

But there are many late autumn plants scattered through other than the sunflower family. Along the streams and standing knee-deep in the wasted and decaying rubbish of the borders is the long, leafy stem of the *Physostegia virginica*, with its slender spike of showy rose and purplish-white blossoms. It is one of the mints in all save the minty quality, and for this peculiar lacking it is often a source of trouble to the tyro in classification. The flowers are complex, the stamens possess an abundance of hairs, in which the circulation of protoplasm may be seen; and, besides, insects visit them.

Of a very different type, perhaps more showy and certainly as interesting to the student of floral structures, is the great blue lobelia (*Lobelia syphilitica*), a frequenter of all low places, where its rank growth and bright deep blue render it a prominent object. This plant with its insect attendants has often furnished amusement for me by the half-hour. The insects seem always in haste, and dodge in and out of these blossoms with a methodical rapidity, each time receiving a new invoice of pollen to be scattered upon the stigmas of other blossoms subsequently visited. Among the most seemingly out-of-place blossoms as to time of appearing were those of the common blue violet. This is strictly one of the spring flowers, but with us for years it makes a second advent, and in some places blossoms so freely as to be no rarity. It has been used for classes of a hundred members for dissection in October. This favorite plant is not as well known in habit as it deserves. Its underground close-fertilized flowers, for example, are unseen, therefore passed by by those who only pick the showy aërial blossoms. The little low, round-leaved mallow, or prostrate mallow—in my boyhood days we called it "cheeses"—is one of our October flowers.

It will be seen that a fair share of the late autumn blossoms are weeds and useless plants. The May-weed (*Anthemis cotula*) is one of those which, if less common and without its rank odor, would be a very attractive plant in both foliage and flower; but, as it is, no one is anxious to give this wayside intruder any high place among the purely ornamental species. In like manner the mullein, or "great American velvet-leaf" as it is sometimes called in Europe (*Verbascum thapsus*), is a plant with some inherent attractions; but, owing to its obtrusive habit, combined with a coarseness and boldness, it can only rank with the weeds. It will accommodate itself remarkably to unfavorable conditions and come up blooming under all sorts of rough if not abusive treatment. There is a strict military air to this plant as well as to one of its October associates in the pasture (*Verbena stricta*). Both have stems much straighter than some ramrods, and one time a friend, seeing the mullein in great abundance upon rolling ground, remarked that they were like ten thousand men marching up a hill. The species of liatris, or blazing-stars, are of the same strict habit but vastly more showy. We have three species of these charming rose-purple composites, all of which flower late in summer and remain to display their marvels of beauty long after the tender plants have served their time.

Among all the late blossoms there are none for which I have a greater fondness than the gentians. They come, with their mingled purple and blue, at a time when those colors have become unusually rare, for they are never common at any time of year. Some of the species bear flowers that long seem upon the verge of coming into full bloom, and disappoint those who look for wide-open flowers. They are somewhat bell-shaped; into the plaited opening, otherwise nearly closed, the bee or other insect pushes its way in search of nectar and pollen. Upon the exit of the winged visitant the corolla again closes, to the exclusion of everything except its insect attendants. The most charming of all the species of this late-flowering genus is the celebrated fringed gentian, so named because its long corolla ends in a most delicate row of long, fine, hair-like projections, suggesting the heavy eyelashes of a beautiful girl. The tint of the whole blossom is a pure and delicate blue, caught, as it would seem, from some patch of October sky, margined by flecks of fleecy clouds. These gentians, as well as rich specimens of a cousin to the thoroughwort and boneset, with great clusters of pure white flowers, might be gathered any late autumn day, the former in the low prairie, the latter in the tangle of frost-bitten herbage in "the timber" along the water-courses. The boneset flowers suggested, in their exhibition of white, the approach of winter, when all the copse is covered with a mantle of snow and the stream is locked in the embrace of the frost-king.

One of the latest of the autumn prairie flowers—and one not found by me until drear November has come in the wake of Indian summer weather—is the ladies-tresses, an orchid of no striking beauty, but, in a region where orchids are rare and arriving after the eleventh hour, it has its full share of interest. The plants are single-stemmed, few-leaved, and the small, pure white flowers are so arranged upon the long spike as to assume a spiral inflorescence, from which fact the common name doubtless originated in the fertile mind of some imaginative lover of plants. If the witch-hazel had been a member of the prairie flora under consideration, it would have been in its place of honor at the close of this list; but, as it is, the orchid and the aster, the shepherd's-purse of the wayside and the prairie must vie with the pansy in the flower-garden for the last place in the floral calendar of the year.

The reasons assigned in a previous article for the early blooming of plants hold good here for those that develop their flowers late in the year, and can be briefly condensed into the expression that, in the experience of the species, it is probably found an advantage to be somewhat out of the season. A single store upon a side street may do as well as any one in the market-place, provided it is thoroughly accommodated to the situation: competition, or the absence of it, is likewise an element not to be ignored in the consideration of the time of blooming of flowers; and no one can but rejoice that all plants do not produce their blossoms during the same day or week or even month of the year.

[The above article has been prepared from notes taken by the writer while occupying the chair of botany in the Iowa Agricultural College.]

THE DUK-DUK CEREMONIES.

By WILLIAM CHURCHILL.

RELIGION is a vanishing quantity in the western Pacific, and the farther west one goes by so much the more rapidly does this sentiment vanish; dogmatic theology and its practical profession are alike absent from the thought and practice of the dark Melanesian. Simplicity marks all the desires of this island savagery, and this same simplicity marks all the spiritual side of life; instead of wondering puzzlement over the hazy ideas of a great first cause, or a hereafter which may in some sort be molded by the conduct of life in the present, the remote islander limits his religion and the spiritual side of him to an ill-defined, scarcely acknowledged fear of the unknown. Worship he has none; even the idea of propitiation of the malign power has not yet occurred to him; and the most that he can conceive of is sedulously to refrain from naming this terrible unknown.

Another circumstance deserves note because of its interesting coincidence with this absence of faith. What internal connection there may be between the two, if indeed there be any, is most obscure, for the reason that these people are as yet little known, and are very chary of communicating any information concerning these two features of their life. It is noticed by the careful observer that just in proportion as the forms and formulas of religion disappear from the life of the savage communities he visits, so there is a marked increase in the prevalence and power of the secret societies which seem to take the place of priestcraft and kingcraft.

Melanesia presents a very long list of these associations of men who are inducted into some secret or other, who are threatened with the most severe penalties if they divulge any part of these mysteries to the profane, and who are provided with signals for the recognition of other possessors of the same mysteries; and in more than one instance it has been observed that these signals have been recognized and regarded by people on far-distant islands, speaking a dissimilar tongue, and so remote as at once to preclude any chance of frequent communication. The very existence of these mystic orders is as far as possible kept secret, and it is only by long and patient study of the people that even the merest outline of their methods can be ferreted out. That they exist and exercise a tremendous power over the people is certain; that they are more powerful in communities devoid of religion is a fact; and with almost equal certainty it may be said that these secret societies are in some way intimately connected with the practice of polyandry, which it is evident has only recently among the Melanesian races yielded to the present system of polygamy.

New Britain, at the most remote and the most savage verge of Melanesia, shows to their best advantage the absence of the religious sentiment and the development of the secret society. Both are well exhibited in the ceremony of the Duk-duk, which plays a large part in the life of the community. It has not often been seen by white men, for the reason that its performers or devotees are fierce cannibals, and of those few who have seen it none have been able to learn more than just what little they saw. The reasons for the ceremony and the rude symbolism which underlies it have been carefully concealed under the seal of the oath of mysteries, and have evaded the traders who have witnessed the presentation of the ceremony on the village green. That this account can go any deeper into the mystery than others is due solely to a happy chance by which the writer was received into one of the New Britain families, and was allowed to progress into the chief mystery by initiation in due form. The public performance of the Duk-duk will first need recounting.

Upon a day not previously announced to the people the ceremony takes place. It is early in the morning, and the people have not yet scattered to their customary occupations on the beach or in the jungle that lies behind the village; the chief stands at the door of his house, smoking and watching the knots of the villagers; by his side stand some of the elders of the village discussing petty politics; the women chatter loudly at the spring, and the children are noisy at their sport. Suddenly there comes the warning cry, "Duk-duk!" there is a sound of some one crashing through the canebrakes, and the scene at once changes. The men hurry to take their places at the doors of their dwellings, brandishing their weapons of warfare; the women shriek and rush for shelter; and the children scurry home in hot haste, stumbling and falling in their hurry, but showing all the signs of terror. The noise in the jungle grows louder and draws nearer, the last hedge of rustling canes is parted, and a strange figure appears running at the top of his speed.

It is the Duk-duk. Near the ground are seen the legs of a man black as tropical skies and a hereditary inclination could make them, shining with cocoanut oil, and in rapid motion, as of a man who runs and dances with wild pirouettings as he goes. With the flashing shins all semblance of manhood ceases; what the eye sees is not a man but an animated extinguisher, a gigantic copy in reeds and grass of the tin cones with which a generation that had not yet struck oil was wont to put out its tallow dips. Ten feet high, this extinguisher prances through the village, rushing furiously at every house as though intent upon extinguishing all who might be within, stopping short at sight of the armed householder only to whirl high in air and dart away to the next house, followed by the armed man from every house he has visited. It is a mad dance, this speechless prancing of a rushy cone followed by a constantly lengthening queue of silent warriors grimly brandishing clubs and poising spears. From house to house it goes until every house has been visited. If the Duk-duk chance upon a man away from the shelter of his roof-tree, meet him crossing the village green, or lurking in one of the narrow alleys, he charges down upon him, and destruction seems imminent. The man thus met lifts his arms with certain symbolic movements of the hands and fingers; his sign is recognized, the cone dances back, the threatening clubs are lowered, and the stroller falls in at the end of the procession. If man, woman, or child thus met out of doors failed to give the proper sign the clubs of the warriors would fall and the extinguisher would dance upon the prostrate form, dyeing his feet and ankles and staining the long grasses of his disguise with the blood of the profaner of the mysteries. Sometimes it happens that some man not deemed worthy of initiation is caught unawares before he can gain a place of refuge, and in every such case the full penalty of death by clubbing is exacted.

Sometimes a man met out of cover gives the proper sign, but the Duk-duk still dances before him, and the warriors still threaten but do not strike. Two others then leave the line and stand by the side of the man thus menaced, always one of the boys just growing into manhood; together they all three give the sign, the disguised fugleman and his tail dance away in search of other victims, and the two sponsors lead the lad away to an inclosure near the woods on the outskirts of the village.

The dance is done with a final flourish before the house of the chief, who would be chief no longer if he incurred the enmity of the Duk-duk; the stragglers have given the proper sign and have joined the dancing queue, or been led away by their sponsors, or else they have not hailed the mysterious visitor in the due and ancient form, and lie bloody where they stood, mere dead things. There is a flourish before the chief's house, and then the dancers, still strangely silent, follow their leader by the most direct route to the inclosure of high palisades where await them all such as they have met who have required sponsors; there is always one such, frequently more; for it is generally for the purpose of initiating these candidates into the mysteries that the Duk-duk makes his visit. When the last dancer has entered the inclosure, a thickly woven hurdle of canes is tied at the gangway, the dancers prance in a constantly narrowing circle about the novitiates, threatening them with clubs and spears and sharp stone axes. At last the dance is finished; the chief seats himself at his appointed place, where a small mat lying on the ground marks the spot; the dancing extinguisher gives over his dancing for the first time since he burst in upon the village, and stands behind the chief; the others stand along the stockade except that side opposite the entrance; the novitiates stand in the center, and their sponsors form a little group a few feet away. When all have taken their places, the deeply masked figure moves toward the novitiates, no longer with a dancing step, but so crouched that his legs do not appear beneath the cone of reeds, which thus seems to possess the power of independent locomotion. The young men again make the signal which has met with a certain measure of success, but this time no sponsors aid them. Before each in turn the cone rests motionless, and the chief, then speaking for the first time, cries out, "Let him be put to the proof!"

Obedient to the royal command, the two sponsors lead the candidate to the vacant side of the yard where the battered wall gives evidence that it has been many times put to the same use. The masked figure also moves to a position close at hand, where he can easily inspect the bearing of the young man under the ordeal. The sponsors then draw back some space away and each lets fly his spear, which whizzes by the novitiate and sings as it sticks in the wall not an inch away from the flesh. If the novitiate wince as the deadly weapons hiss upon him, the keen eye of the Duk-duk would notice it, and at a signal every spear in the inclosure would on the instant be hurled with unerring aim upon the candidate who has been found unworthy. Having successfully passed this ordeal, the candidate is conducted before the chief, and the sponsors fall back a step or two. With a quick glance from one to the other to get the time, they swing their clubs and let them fall as one upon the young man who is toiling over this rocky path toward an insight into the mysteries. If he bear this trial without a show of pain, he has passed all the tests that will be required of him. At a sign from the chief, the hurdle will be cast off from the gate, and the procession reformed will take its way still farther into the half twilight of the jungle. Meanwhile in the village the women and the men who have not shared the great mystery creep out from their houses in fear and trembling and pick up the victims of the masked figure's mystic vengeance.

This ordeal of the spear and club is not the only preparation of the young man for the mystery of the Duk-duk. When he arrives at the age of puberty he is told that he can not take his rank as a warrior and a man of property, but must always remain a communal slave, unless he is hardy enough to sue for entrance to the light of the great mystery. The distinction is one that is plain to him, and he probably does not hesitate in making his choice, but applies to his chief to be prepared for that which is to come. If his prayer be granted, and that is discretionary with the chief, two men skilled in the mystery are detailed, under the title of "brothers of the wood and sea," to educate the postulant. They conduct him away from his home and to a secluded spot in the wilderness of jungle. Here the postulant is made to build a house and hunt a supply of food. At first he is examined in his bodily exercises and in his proficiency in the few arts of his savage life. From these material considerations his tutors pass to more recondite matters. They instruct him in the secrets of the sea and the forest, each according to his title. When the candidate can pass a satisfactory examination in this branch of his education, his tutors acquaint him with the history of his race and the list of its hereditary friends and immemorial foes. Last of all he is taught to fear the spirit of the hidden fire which from time to time boils up in the craters and rushes down the slopes, marking its path by hot ruin and stony destruction. This power he is taught to fear as one that can not be averted, and that he must always be mindful of if he will save himself alive. All this has consumed a month or more, according to the ability of the postulant to master the lessons set for him to learn. When he finally succeeds in satisfying his masters, the brethren of the wood and sea, they take leave of him.

"We have taught you now," they say, when the time has come for their departure, "much of that which you must know in order to become a man and share our mysteries, and all that it is our duty to convey. That which remains will be taught you by another who will come to you when he is ready, and until that time you must not leave this place, nor speak to any man, nor sleep nor eat. To-day you may have to eat anything you please, but remember that whatever you eat to-day you must never taste again, nor must you so much as speak its name. Choose, then, that which you will now eat for the last time, and eat well, for days may pass before he comes who shall teach you the rest." When the postulant has eaten, the hut is cleared of all that it contains, and the brothers of the wood and sea sew mats over the doorway before they go.

His meal over—the last of that particular food which he shall taste on earth—the postulant composes himself to await the coming of his new master. The day passes, and night comes upon him left alone in a dark hut, in the heart of the dismal wood, and without fire or the means of making it. He remembers that he is forbidden to sleep, and, as he sits, expecting the coming of he knows not whom, his strained senses are awake to a chorus of unfamiliar sounds which bring him terror. The day comes, but brings no food, no water, no master. As the sun declines, and he sees ahead another terrifying vigil, he looks toward the door. Between him and food, fire, and home, hangs but a light mat, yet it makes his dungeon as secure as though forged of steel, for a *tabu* is on it. As the first night, so is the second; as yesterday, so goes to-day, only the hunger gnaws with a sharper tooth, the thirst parches the throat and mouth still more, and the nerves are set on edge through lack of sleep. The vigil of hunger, thirst, and sleepless eyes may last two, three, or four days; but when even savage endurance can bear up no longer, the master comes. He enters the house in all his glory of rushes and colored grass woven into a cone, and stands before the lad. Little wonder is it that, worn by his ordeal, he should fear this mysterious figure, which he has always been taught meant death to look upon. If his fears overcome him, he is initiated into the mystery of the club, which strikes but once, and there an end. But if he bears up bravely under the trial, the Duk-duk teaches him the sign of recognition, gives him a new name by which he shall hereafter be known, and bids him go to his own home, avoid his childish playmates, tell no one the lessons that have been imparted to him, but await the next visitation, when the Duk-duk will surely claim him, and if he passes the remaining trials will induct him into the mysteries.

The young man goes home, announces his new name, and by abundant food and rest recuperates from his recent privations. Meanwhile, the Duk-duk day is drawing nigh; the profane do not know when to expect it, but the initiated know it to be the day of the new moon, on which the mullet at dawn swim so near the surface of the water as to break it into ten thousand ripples. If, on this day, the fish swim deep at dawn, the ceremony must go over for another time, when these two phenomena occur together. If the fish swim high, the Duk-duk appears, the postulant makes the signal which has been taught him, his sponsors—the brethren of the wood and sea—answer for him, and lead him to the yard where he undergoes the final ordeal, and, succeeding, is carried along with the initiated to enter into the mysteries.

He is led to a path which is adorned with the marks of a stringent *tabu*, and here it is made known that this *tabu* is hereafter not binding upon him. By tortuous ways, winding in and out through the dense canebrake, the path leads to a large house screened from sight in every direction. Before the house and, indeed, all around it, is planted a stockade with one gate. Here he is bade wait while the rest enter. At last comes one to the gate who bids him enter, having first made him undertake, under penalty of death, not to divulge to women, to children, or to the uninitiated, anything of that which he may see or hear within. Entering on this stipulation, he finds the yard crowded with the warriors of his town, who welcome him to their ranks, call him by his new name, and congratulate him on passing all the tests so well. When this social function is over, he is led onward to the door of the house, there to receive his martial equipment. As he enters the door he notices the Duk-duk extinguisher standing in a farther corner, and squatting before it some half-dozen of the most considerable men of his tribe, including the chief. The bow and arrows, the spear, the heavy club, and the short-helved stone axe are then given him by the chief, with a few words of counsel, bidding him use them as a warrior should, and advising him that, if he use them well, he may in time be chosen to sit within the house, while the others are privileged only to use the yard. Then another of the seated figures—he who has that day worn the great Duk-duk mask—arises and chants the mysteries, to which, at proper intervals, the initiated standing near the door respond by an answering chant, which has no meaning that they know; the words are in an unknown tongue, and have been handed down by tradition from they know not whom. From the sound of some of the words even in their mutilated condition, and from the frequent use of the remarkably significant word Saba, it is possible that this refrain preserves a trace of an ancient Polynesian migration over these islands, just as the Derry-down chorus in English is a Druidical remnant.

For the rest, the mysteries, which have very little interest for the white man, are merely a rationalistic rehearsal of a creed of unbelief. Everything which by the uninitiated is held as of particular obligation, is here chanted as something that the initiated must rigidly impress upon the profane, yet which for themselves they may disregard. The *tabu* is to have no force for them except the great *tabu*, with a flock of hair on it, and that they must not break through. All others they may transgress, if only they do it slyly, and so as not to raise public scandal among the women and the others who are bound by their provisions. They must teach the uninitiated that there are malign spirits abroad by night, but they themselves need not believe anything so stupid. In a word, they form an association for the purpose of playing upon the innocence and credulity of their fellows, and right bravely do they keep up the imposture. One only belief do they profess, and that is in the spirit of the volcano-fires, and even that is discarded by the inner degree of the Duk-duk, those half-dozen men who sit within the mystic house and dupe the initiates of the minor degree as all unite to trick those outside. And the reason is this: the half-dozen members of the most secret rank profess to one another that no better system of governing a savage community could be devised than this ceremonial mystery of the Duk-duk.

THE SENSATIONS OF PLEASURE AND PAIN.

BY DR. E. HEINRICH KISCH.

ALL our sensations, from the most trifling pleasure to the highest delight, from the hardly perceptible discomfort to the keenest anguish, the whole gradation of manifold variations of feeling, originate from the propagation of excitations from without through the nerves to the central organ of the nervous system and to consciousness. The nerves are the conductors of the stimulus-waves which go to the nerve cells of curious terminal forms in the brain and spinal marrow; and every excitation that touches any part of those conductors releases a sensation, the pleasant or unpleasant character of which depends first upon its intensity. To a certain degree every moderately strong excitation affecting us is agreeable and begets a feeling of pleasure rising to lively delight. An excitation surpassing this limit calls out an uncomfortable feeling which passes into pain. A gentle stroking of our skin, for example, is enjoyed; a strong pressure upon it evokes an uncomfortable feeling, which, continuing, passes into pain. Harmonious musical tones please our ears, but discordant noises make us miserable.

That a stimulus striking the sensitive nerves should reach our consciousness as a pain depends not on the force of the attack only, but also on the delicacy of the nervous system, which varies with different men to a considerable degree. Thus, many persons having finely developed organs of those senses can smell and taste many things of which other persons can hardly conceive; and much that is painful to an over-delicate lady causes no inconvenience to the hardy, coarse rustic. Also in various conditions of disordered health the whole nervous system or part of the sensitive nerves suffers from excessive sensitiveness, in consequence of which insignificant affections cause agony.

Neuralgias, or pains in particular nervous tracts, may be brought about by various causes—by disease in the terminal ramifications of the nerves, from disorders in the nerve-stem, through illness of the brain or spinal marrow, or from some irritation affecting another distant nerve, transmitted to this one through the central nervous system by what is called a reflex process. The common expression, "nervous pain," conveys no distinction respecting the character or source of the affection; but to the physician it is a matter of great importance to determine the precise source of the affection and the means of contending with it.

One of the most common neuralgias is a pain in the eyes; it is felt in the region of the trigeminal nerve, and frequently becomes almost unendurable and very obstinate. It occurs usually in single attacks, which return at various intervals and last sometimes only a few minutes, and sometimes a quarter of an hour or more. The painful feeling, which may be described as that of a boring, piercing, stretching, or tearing, generally radiates from a circumscribed spot in the neighborhood of the nervous ramifications, in the region of the eyes, face, and lower jaw, and may extend to the neighboring nervous regions, to the back of the head, the arms, and the breast. It not rarely becomes so fearfully intense and rasping that persons afflicted with it act as if mad, tossing themselves violently around and crying out in the most heart-rending manner. To this are added disorders of sensation. The eyes become red, vision is troubled with specks and spots, the flow of tears becomes excessive, the hearing is dulled or vexed with hummings, and the patient suffers from an unpleasant taste and burning in the nostrils. Companion afflictions set in, like twitchings and cramps of the facial muscles, eruptions on the skin, swellings, and a whole list of other disorders. To these bodily woes are added mental depression, life becomes a burden, and the sufferers are sometimes tempted to suicide.

This neuralgia may arise from a variety of causes; from a cold, an unsound tooth, from general sickness, or from debility or exhaustion. It is sometimes connected with disorders of remote organs, as of the digestive system, and by reflex action from pains prevailing there.

Sciatica, or hip-gout, is another frequently occurring neuralgia, which has its seat in the hip-nerve and its branches, and is thence transmitted through the whole lower part of the system, from the pelvis to the toes. The pain is usually confined to certain points, and rises on motion, and often at night, to great heights. It is a disease of middle age, prevailing with men and women, and originates from a variety of causes. The hip-nerve is exposed by its situation to be easily injured by cold and accidents; and the affection is often brought on from stagnation of blood, disorders of the lower body, and internal diseases. It is very persistent, and may interfere with business activity and occasion sickness through many years.

These diseases are cited as examples. Many other nerves are the seat and starting-points of pains which after long continuance give rise to an exaggerated sensitiveness of the whole nervous system, to increased acuteness in all the nervous regions, by which sound thought and feeling are deeply disturbed. It is evident that full attention should be given at once to nervous pains and the means of counteracting them. First, every pernicious influence which may directly exert an irritating influence upon the nerves should be removed; then the remote causes which manifest themselves by nervous pains should be dealt with.

The removal of a decayed tooth may cure a face-pain at once and forever; taking away a body pressing upon the hip-nerve may be a complete remedy for a sciatica. Like ends may be reached in other cases by a regulated way of living which will lead to improved digestion and a more healthy circulation. The simple operation of an aperient, as I have had occasion to observe at Marienbad, has sometimes at once alleviated nervous pains that had defied every sort of treatment for years. Yet we do not always succeed in elucidating the causes of such troubles and removing them.

In such case the task of the physician, seeking to alleviate the pain, is to reduce the sensitiveness of the nerves. Sometimes he seeks to attain that object by applying counter-irritants on the skin along the course of the nerve or in its neighborhood. Of such are mustard-plasters, Spanish flies, burning, and dry cupping. Electrical treatment constitutes one of the most important applications for curing sick nerves. With alleviation of the pain, weakening of the attacks, and quieting of the nervous excitement, it also often induces improvement and cure in desperate cases. The same is also frequently accomplished by the use of warm baths, such as may be had at many natural thermal springs, sulphur, and other medical baths. Sometimes, when the pains are refractory to the application of heat, cold baths, washing and rubbing are of effectual service; and the cold-water method not rarely achieves real triumphs in cases of long standing, particularly when the neuralgia is the result of a cold, and it is desired, by hardening the organs of the skin, to make them less sensitive to changes of weather. Local applications of cold in the shape of ice-bags, cold poultices, etc., afford effective means of reducing the supersensitiveness of a nerve. Sometimes drugs are necessary which have the property when introduced into the blood of increasing or reducing the power of feeling. These remedies are applied outwardly or inwardly, and many of them have been known from ancient times. Narcotics taken inwardly, like opium and morphine, should be used with great care, and reluctantly. Beneficial and even indispensable as may be the pain-stilling and quieting operation of these drugs, it must not be forgotten that the human organization easily accustoms itself to them, so that ever more frequent application and larger doses of them are demanded, and, at last, bodily disease and mental disorder are brought on through the general poisoning they occasion. The moment when a man afflicted with neuralgia receives the morphine injection for the first time, to free himself temporarily from pain, may be decisive for his whole future life. It soon happens that the anodyne is resorted to, not merely for unendurable nervous attacks, but for every little discomfort, care, and grief, so that the veil of forgetfulness may be drawn over the unpleasantness and the pressure of the unwelcome reality may pass away in dreaminess. Thus the unhappy man sinks from step to step in the slough of opium-poisoning, from which deliverance is possible only rarely and with difficulty. Energy, the power of resistance, the sense of duty and pleasure in action are lost, and he becomes a physical wreck; indolent and indifferent, timid and uneasy, emotional and excitable, the unhappy man presents the most critical symptoms of what is called "morphinism." Similarly terrible consequences follow the habitual use of other quieting drugs, including the preparations of cocaine. Those, therefore, who suffer from nervous disorders can not be too earnestly warned never to use any such preparations, except in extreme cases, by the prescription of their physician.

Massage has recently played a considerable part among the remedies applied for the removal of nervous pains. Good effects are obtained in neuralgias which originate from colds or stagnation of the blood by means of the kneading and the muscular exercises which are implied in this term. The structures in which the disordered nerves branch out should be worked in all directions, but only by experienced, intelligent hands—with pressure, rubbing, kneading, shaking, and moving, in order to remove the disturbance. Rough handling by awkward persons, such as those to whom the process is too often intrusted, may do more harm than good. Health gymnastics is included among the movement cures which are resorted to for the alleviation of nervous pains. In many cases, too, the opposite course—complete rest—is prescribed for quieting the excited nervous system, for the reduction of oversensitiveness.

In desperate cases, where medicines and mechanical applications have failed, surgical operations are called in, to remove the pain by severing the nerves. The results which have been often attained by this operation justify its application.

The best protection against nervous disorders is found in sparing the nervous force; in avoiding overexertion of body and mind; in systematic practice of bodily exertion and muscular exercise; in a wise alternation of work and recreation, and in hardening the power of resistance of the body and steeling that of the mind; in everything that can protect our emotional nature against degenerating into sentimentality, our feeling into tenderness.—*Translated for the Popular Science Monthly from Die Gartenlaube.*

ANIMAL LIFE IN THE GREAT DESERT.

By WILLIAM MARSHALL.

THE surface of the earth, with its division of land and water, its diversities of climate, and its various elevations, offers to the world of plants as well as to animals a complexity of life-conditions to which their organisms are compelled to adapt themselves if they would even exist.

Few regions exhibit to so large an extent such even, uniform, and original character, as that vast desert expanse which stretches through southern Arabia and northern Africa from the Persian Gulf to the Atlantic Ocean. This uniformity is the result of the correspondence of the desert tract with the same degrees of latitude, and of its never departing from the subtropical regions. Since, also, the elevation of the land seldom greatly exceeds 3,000 feet, the temperature conditions, however much they may vary in single places in the course of a day, are as a whole more uniform than they would be in a similar tract running north and south, and marked by important elevations. The midday heat in the desert rises to over 120° Fahr., while at night the cold, in consequence of the rapid radiation, sometimes makes itself very unpleasantly felt, and in winter descends below the freezing-point. More unfavorable to the development of animal life than the temperature is the want of water, both running and standing, as well as the absence of rain and dew. Sufficient water and a thin surface soil are found only in the oases, which exercise an influence over the distribution of life like that of the presence of the numerous islands in the great ocean. Even including the oases, vegetation is very scanty; the immense territory of the Sahara, with an area of upward of 2,500,000 square miles, harbors only 560 species of plants; while the Japanese Islands, having only one seventeenth the area, 150,000 square miles, support not less than 2,745 species. Most of the desert vegetation is deficient in quality as well as quantity; the plants are sparse, generally small, with inconspicuous gray leaves, and often covered with sand. Many plants that are usually annual develop, under the influence of life in the desert, long roots reaching down to the ground water, and become perennial. Monocotyledonous plants are represented only by dry, tough grasses, like the *esparto*, and by a few palms in the oases. Woods, the chief resorts of animal life, are wanting.

Most of the scanty fauna is concentrated in the oases. The oasis of Bachariel, according to the French entomologist Lefevre, swarms with insects at certain seasons, which would yield a rich harvest to the collector if he would stay there long enough to secure the varieties. On the borders of the deserts, where the cultivated land cuts into them, especially in the region of the Nile Valley and the Red Sea, organic life is fairly well developed. The broad valleys in those regions are changed after rains into green meadows, and in January the perennial plants in every mountain-clove and ravine are covered with foliage and flowers; and annuals spring up, affording a luxuriant flora from February till April. Day moths sport themselves, in few species indeed, but in multitudes of individuals. Along with them buzz numerous wasps and flower-visiting beetles, and in the oases the troublesome ants are associated with a series of insects whose larvæ are bred in the water. Dragon-flies appear in multitudes, often swarming like locusts, and miles from the water, and myriads of stinging flies for short periods make the sojourn of Europeans intolerable. The pests of the home are here too, and vermin that make life a burden even to camels.

Scorpions are plenty, both in the oases and the desert proper, and spiders abound at the opening of the rainy season. Especially is this the case with a little purple spider of a velvety sheen, of which, according to Nachtigall, the people of Bournou believe the red velvet of the Western countries is made. Little crustaceans are numerous in the springs, and one species (*Artemia oudenyi*) occurs so frequently in some of the salt lakes of Fezzan as to serve, with the larvæ of certain flies, as food for the people. Fish are found in the ponds and underground springs; but the last are individuals which have, as Carl Vogt has shown, only casually reached the springs through underground channels from surface waters; for they betray no sign, either in coloring or the structure of their eyes, that they were ever accustomed to constant darkness. Of double interest is a fish living in the hot springs of Tofra and Lafra, in Tunis; first, because it can bear a temperature of 167° Fahr. without injury, and also because it belongs to a genus of which the other species live only in the sea. A few small fresh-water mollusks are found here and there, and land shells of a class which are capable of enduring protracted drought in a passive condition, and reviving when it begins to rain, and thus afford a remarkable example of adaptation to life in the desert. Frogs and salamanders, which do not easily adapt themselves to an arid environment, can not exist under the conditions of life that prevail in the Sahara, not even in the oases. Some reptiles, birds, and mammals fare better there. These vertebrates, in fact, with insects, are the only animal inhabitants of the desert.

Nearly all these animals, from lions and gazelles to locusts, wear the yellow color of the desert sand, verifying the phrase of the Latin poet, "*Flavæ leæneæ arida nutrix*" ("Dry nurse of the tawny lioness"). The weakling is thus protected by a coat that withdraws him from the lurking view of hidden enemies, while the strong beast of prey may conceal himself behind a rock, by the aid of the color of which he can the more easily steal unobserved upon his prey. Only such animals as fear no enemies display so conspicuous a color as black. "What strikes the traveler," says Carl Vogt, "when he comes to the desert from the coast, where the greenness of vegetation predominates, is the absence of all lively colors—of red, green, and blue, in the animals." The full-grown ostrich is white and black; it is so large and swift that it has nothing to be afraid of but mounted men, and its food is not of such a kind that it needs a protective coloring in order to approach it without observation. The great desert crow (*Corvus umbrinus*), in which the negro of the Soudan perceives and worships his "uncle," is strong enough to keep off all its enemies, and agile enough to seize its prey when it has once had its eye upon it. The beetles, too, of the desert are black; not the "black beetles" of the Mediterranean region, but other kinds such as often have bright colors or a metallic luster. Carl Vogt asserts that these beetles are defended by an offensive odor or taste, that they have highly arched wing-covers and a depressed corselet or a withdrawn head, and can feign death when they believe they are threatened. When driven into close quarters, they become motionless, assume the likeness of the excrement of gazelles or goats, and thus avoid pursuit.

The coloring of the other animals is often remarkably like that of the pebbly sand. Those creatures—beasts of prey, ruminants, and birds—which are not confined to the soil, but roam or fly around, are tawny, but sometimes striped with different tints. Fowls, larks, stone-chats, running and wading birds, do not form local races with clear or dark feathers, and have not the faculty of changing their color according to the background against which they may for the time find themselves. Another rule prevails with those animals which occur in districts of limited extent. The snakes and lizards of the desert, even when they are of the same species, wear different vestures according to their dwelling-places, while the colors of the same individual, of the lizards at least, are themselves changeable. The proverbial chameleon is not the only animal which is capable of unconsciously adapting its colors to those of its surroundings. Eminently accomplished in this respect are the plaice, while our brook-trout, frogs, and many lizards possess the useful faculty in a less degree. The spring-tailed lizard (*Uromastix acanthinurus*), which Carl Vogt observed in captivity, presented in darkness and the shade a dull-gray slate color with indefinite blackish marblings, but when exposed to direct sunlight became brighter and brighter, and at last appeared of a dirty cream-color, with small, deep-black spots, resembling in its hues the fine desert sand mixed with black grain-pebbles. Another lizard of the Sahara (*Trapelus ægypticus*) possesses the same peculiarity in a higher degree. The property of changing color depends on the presence of certain dark cells in the tissue of the skin, called *chromatophores* or color-bearers, which, contracting, under reflex influences of the nervous system, permit the full display of the ground-color of the animal, or, expanding to a certain extent, overlie it.

The power of changing color also exists in insects, but less commonly. We more frequently find among them varieties which are distinguished by constantly different but always protective colors. Lefevre observed in the Libyan Desert curious praying-crickets of the same species as to other marks, which were brown on a brown soil, and a hundred paces away, on white fossil shells and fragments of limestone, were correspondingly white. They resembled the background against which they stood so much that the French naturalist could not detect them except when they moved. They had other peculiarities, among them wings so contracted that they could not fly; a phenomenon which is sometimes met among insects and birds inhabiting large territories and islands where they are but little exposed to pursuit. They have disused flight with advantage, for only a good flier can keep his ground under the conditions that prevail in such places. A weak flier would be taken by the wind and carried off helpless to destruction.

Sand-fowl (*Pterocles*) are represented by fourteen species in the Old World, and are spread from the deserts and steppes of central Asia and India through all continental Africa. They visit southern Europe as breeding-birds, crossing the Strait of Gibraltar into the Iberian Peninsula. Their home is never in wooded regions; the more barren, stony, and arid the land, the less the extent of water and swamps, or contrast of mountain and valley, the more agreeable it is to them. In such regions live these modest birds, on the little which the land affords them, often on the sparse halfa grass; yet they can be found in coveys of hundreds, in places where it seems a puzzle how anything can live. Only ability to move speedily from place to place can make this possible. None but accomplished fliers can exist under such circumstances, and then when gathered in large groups. "It is easy for them," says Brehm, who has observed them more closely than any other naturalist, "to execute a flight, before going to sleep, which would appear to us equal to a day's journey or more." At breeding-time the coveys separate into pairs, and live in this state for a considerable period. When the brood is hatched they are still confined to their household duties, and, not being able to roam around, many suffer for want of the food which their narrow domain does not afford. Life in the desert is, therefore, one of the factors by which the sand-fowl is forbidden the polygamy affected by other members of the gallinaceous family. Scarcity of food also affects the life of these birds by adding to their hours of labor; for they require more time to find the quantity of food they need than other birds whose tables are more richly furnished, and may often be seen, when the moon is shining, active during a part of the night.

Their plumage is strikingly like the soil of their home, though I doubt if they are aware of the value of the feature, as Brehm believes. The squatting attitude and the stillness they assume when they believe themselves in danger are probably only instinctive. Bitterns in like manner resemble in plumage, and in the position they assume when they perceive anything suspicious, the old reeds and bushes on the shore. I have observed the same changes in captive birds when suddenly frightened, and when it can not be of any use to them. It is an involuntary reflex action, like the bristling of the hair and the exposure of the teeth in angry dogs.

With extraordinarily acute sight and hearing joined to a great power of flight, the sand-fowl is little exposed to danger, except when a desert fox or fennec succeeds in stealing upon a covey at their noon-rest, or at night, and snapping up one or two of the number.

This animal, which is a little larger than a cat, is a true child of the desert, and is represented by local varieties through all Africa. Its color is the characteristic yellow of the desert; it has a fine growth of hair on the paws, which prevents its sinking in the fine sand and muffles the sound of its footsteps. The most striking of the features that have adapted it to its abiding-place and its way of life is in a certain sense the complement of its soft foot—a very sharp organ of hearing, the sound-catching outer part of which is unusually large. Its eye is not adequate to perceive its favorite prey, so well protected by its color; and there is a limit to the development of the organ of sight in an animal which, while it does not shun the day, is eminently nocturnal; and, as is often the case, another sense, that of smell, comes in, besides the hearing, to take the place of sight. Hearing is the night-sense; and the fennec can hear the slightest movement of the sleepy *khata* (*Pterocles alchata*) at distances almost incredible to men, and slip upon its prey with noiseless steps. Then a leap, and one of the little sleepers, before it is aware of what has taken place, has breathed out its arduous but not unpoetic life; while its companions rush away affrighted, with loud cries of "khadda, khadda!"—*Translated for the Popular Science Monthly from Daheim.*

ADELBERT VON CHAMISSO AS A NATURALIST.*

By Prof. EMIL DU BOIS-REYMOND.

IT is one of the lamentable consequences of the rapid expansion of human knowledge in this century that, while the power of comprehension and the adaptability of individuals continue essentially the same, the division of knowledge and mental labor is ever increasing. The paths which scholars and investigators follow are constantly becoming narrower, tending toward more contracted goals, and more distinctly separated; and in our historical view of recent times we regretfully miss such Briarean giants as he whose memorial day we are celebrating. Men like Leibnitz not only give by their wide vision and comprehensive power a conception of the human intellect in its highest manifestations; not only does a mutual fructification of different departments of knowledge take place in their minds through the meeting of different views; not only do they form, like an academy, a bond of union between accomplished labors in widely separated regions of knowledge; but, while they extend its efficacy in many directions more accessible to the common people, they create a wider participation in it than had formerly been given. In their person, mankind honors science; and they therefore endure in the general recollection as memorial stones of human progress after the waves of oblivion have long surged over the names of the makers of the most meritorious single investigations. Let us not delude ourselves. The only member of the Physico-mathematical Section of the Academy to whom a public monument has been erected, Alexander von Humboldt, owes that distinction not to the professional efforts by which his memory is kept alive in these halls, but to the grand recollections which his eloquent pictures of nature, the inspiration toward the true and the good that radiated from him, and his incomparable world-survey, have heaped around his name.

A second member of the Physico-mathematical class is shortly to be commemorated by a monument in one of the public places of our city—a man who, while his fame can not be measured with that of Humboldt, is comparable with that eminent prototype in the universality of his mental interests, the diversity of his work, and the place which he occupied as between two nations—our ADELBERT VON CHAMISSO. It is not, however, as a naturalist and traveler that Chamisso is to receive a monument, but for his other talents and excellences. We, his successors in this body, can not, however, refrain from recollecting on this occasion the side by

* Address delivered in the Berlin Academy of Sciences on the anniversary of Leibnitz's birthday, June 28, 1888.

which he is related to us, although too early taken away; he only belonged to us for three years. Proposed by Alexander von Humboldt and Kunth, he became a member of the Academy in 1835; and then was removed by death, at the age of fifty-seven years, on the 31st of August, 1838, the fiftieth return of which day is to be celebrated by the dedication of his monument. Unfortunately, we can find only the dates concerning Chamisso's election in the archives of the Academy. Still more strangely, our publications contain no scientific communications from him except a paper on the Hawaiian language, which was read in the general meeting of January 12, 1837, in which he describes himself as an old, sick, and weary man. Yet he was able to look back on twenty years of busy work, during which he left distinct marks on several branches of science; and it seems fitting to me to remind the present generation of some of them.

In what ways and through what vicissitudes the French emigrant's son, Chamisso, rose and became a German poet and the associate of the literary lights of his time is told in his friend Hitzig's biography of him. The energy with which he pursued literary art, when applied to the study of nature, laid the foundation of a scientific career in which he became the academical associate of Humboldt, Von Buch, Ehrenberg, and Johannes Müller; and it is our purpose to enlarge upon this side of his life.

Chamisso's military career ended when in 1806 he went to France as a prisoner of war in consequence of Hanelin's violation of his parole. He formed connections there by the influence of which he received a call after he had returned to Berlin to become a Professor of Greek and Latin in the lyceum about to be established at Napoleonville in La Vendée. The call proved an illusory one, but on his second residence in France he was drawn into Madame de Staël's circle, and received instruction in botany from her son, August de Staël. The name of the species *Staëlia*, Cham., in the order of the *Rubiaceæ*, commemorates the excursions of this pair among the rich flora of the Lake of Geneva and at the foot of Mont Blanc.

That this employment was suited to him will be evident when we recollect how, when he was still a boy at Schloss Boncourt, he "discovered insects, found new plants, and spent stormy nights looking and meditating at his open window, and that all his plays, his doings and undoings, tended to physical experiments and the investigation of the laws of nature." It is, therefore, not strange that he should have devoted himself with decisive earnestness to his new calling. He returned to Berlin, and was matriculated in his thirty-first year as a student of medicine in the newly established university. He studied anatomy under the elder Knape; and was not dismayed either by the dry lessons about bones which the students facetiously called Knape's osteology, or by the unattractive condition of the dissecting art at that time. Thus he went, with a correct instinct, late but thoroughly, through anthropotomy, the true elementary school of biology. He worked in the Zoölogical Museum of Lichtenstein, helped arrange the fishes and crustaceans, and certainly heard Rudolphi on comparative anatomy and physiology, Weiss on mineralogy, which was very attractive to him, Erman on electricity and magnetism, and Horkel on natural philosophy. We are astonished at what he must have assimilated to himself during those three years in preparation for his journey round the world, when we find how well qualified he proved to be for every kind of observation on land and water.

While Chamisso's poems of the time of the war of deliverance contain nothing of importance, the period was marked by his most famous work, and one that has been translated into most of the languages of civilization—The Wonderful History of Peter Schlemil. In Schlemil, in his outer guise, Chamisso presented a prototype in many respects of himself; and in the way that Schlemil comforted himself for the loss of his shadow in striding over the earth with his seven-league boots, "scaling its heights, testing the temperatures of its fountains and of the air, observing its animals and studying its plants, speeding from the equator to the pole, and from one hemisphere to the other, and comparing experiences"—this fiction is only a reflection of the longings by which he was possessed, when, a French-German, or a German-Frenchman, there was no place, no sword for him in the combat. Out of the human tangle into the expanse of nature, the deeps of science, was his solution of the difficulty. Sharp questions have been asked concerning the meaning of Schlemil's loss of his shadow; it is symbolical of Chamisso's loss of a country. The dream described by Chamisso in "Schlemil" was soon to be fulfilled, but not by means of seven-league boots. He was not permitted to join the expedition of Prince Max von Wied-Neuwied to Brazil, but Hitzig showed him a newspaper containing an account of a contemplated exploring expedition of the Russians. A ship fitted up by Count Romanzoff was to be dispatched to the south seas, and was also to seek for a northeast passage from the Pacific to the Atlantic Ocean. Napoleon's return from Elba had just astonished the Congress of Vienna, and set Europe into a fright. In the newly blazing war-fever, in which he would have to remain an idle spectator, Chamisso's dissatisfaction rose to the highest pitch, and, stamping with his feet, he exclaimed, "I wish I was at the north pole with those Russians!" The sagacious Hitzig managed the affair with Russia; and Chamisso, recommended by Lichtenstein and other teachers, was appointed naturalist of the expedition, and reported himself on the 9th of August, 1815, to

Lieutenant Otto von Kotzebue, commander, on board the Rurik, in the roads of Copenhagen.

A happily decisive turning-point in Chamisso's career was reached with this event. In these days of steamboats and railroads, and journeys around the world in eighty days, we can hardly conceive of the importance that was then attached to a voyage like that of the Rurik, and how it would give definite direction and working material to the traveler for his lifetime. Ehrenberg, whose discoveries in the region of the minutest life quite eclipsed his voyages, was a single exception to this rule. The whole of Chamisso's subsequent scientific work may be regarded as the carrying out of what he began on this voyage. It lasted three years, and led from Plymouth to Teneriffe, Brazil, and around Cape Horn to Chili; to Salas y Gomez, past the island world of the south seas, to the Radak chain of the Marshall Islands; thence northward to Kamtchatka through Bering Strait into the Frozen Sea and back to the Aleutian island of Unalaska, where preparations were made for the polar voyage in the following summer. In the mean time the expedition went south again to California, the Sandwich Islands, and Radak; thence northward again to Unalaska, whence the attempt was made to penetrate the ice. At this point the original and real object of the voyage had to be given up. Kotzebue Sound, Eschscholtz Bay, and the Chamisso Islands are reminders within the Arctic Circle of this abortive enterprise, of which the voyage around the world was the only part realized. On the return the Rurik visited the Sandwich Islands for the second and Radak for the third time; then sailed by Guajan, one of the Marianne Islands, to Manila, around the Cape of Good Hope, and past St. Helena, to Europe. In London Chamisso met Cuvier and Sir Joseph Banks, the companion of Cook on his first voyage. On the 3d of August, 1818, the Rurik anchored in the Neva opposite Count Romanzoff's house in St. Petersburg. The expedition was broken up, and Chamisso was left in possession of what he had collected. He declined the invitation to remain in Russia, and returned to Berlin.

Chamisso crossed the line four times during this voyage, approached both poles, and made himself at home in the wastes where the ice rises to mountains, in the rude *yurts* of the tawny fish-eaters of the icy sea, as well as in the palm-crowned splendors of the tropics and among the airy huts of the graceful lotus-eaters of the south seas. Including Europe, he set his foot on the four quarters of the earth, and by a most remarkable coincidence went over Schlemil's journey; and just as Schlemil's boots could not take him over the wide intervening waters to Australia, Kotzebue would not venture to take his cranky vessel through the dangerous Torres Strait, and Chamisso missed seeing the fifth quarter.

Chamisso's voyage was very similar in its general outline with the fruitful one that Darwin made fifteen years later. Darwin was also naturalist on a little war-vessel dispatched on hydrographic work, and the course of the Beagle covered that of the Rurik in many points, except that it visited Australia instead of the arctic regions, and Tahiti instead of the Sandwich Islands. Darwin, according to his Autobiography, does not seem to have been better prepared for his journey than Chamisso. He had never dissected, and could not draw like Chamisso. In one point he was better situated than our traveler: Captain Fitz-Roy furthered his ends, while Chamisso's captain gave him as little attention as possible as a naturalist, and treated him hardly better as a man. His collections were generally thrown overboard, and he had to black his own boots. The Rurik having only three quarters the capacity of the Beagle, the limitations of space were extremely adverse to collecting and observing. So much the more creditable is it to Chamisso that he was able under so many difficulties to conceal and bring home natural treasures of every kind, as well as to make copious fine and striking observations in every conceivable field. He has in this way enriched, first, botany, then zoölogy and natural history, geography of animals and plants, anthropology and folk-lore, geology and geographical physics with facts of greater or less importance. In two points his observations stretched over a wider circle than Darwin's—in that they extended to the polar regions, and that he, paying more attention to anthropology and ethnography than Darwin, studied the languages with which he came in contact. The discomforts of Chamisso's situation on the Rurik were alleviated by the society of two men who shared his scientific tastes. The Russian painter, Login Choris, was ready with his pencil to fix any remarkable features of the landscape or in natural history; and the ship's surgeon, Dr. Friedrich Eschscholtz, of Dorpat, was often an active, expert participant in his efforts.

Like Darwin, in his Journal of Researches, Chamisso, in his Voyage round the World, published his experiences, pleasantly interwoven with scientific observations, upon which a series of "remarks and views," in the third volume of Kotzebue's narrative, afford a commentary. Chamisso's narrative, rich as it is in pleasant details, lacks something that lends a high charm to Darwin's—the thread of a general thought, which we may possibly see more plainly drawn across his journal than he was perhaps conscious of at the time.

Our present effort to distinguish Chamisso's more important achievements is made difficult by his having permitted his energy to be largely absorbed in details. It must first be recollected that he regarded himself as a systematic botanist. Shortly after his return to Berlin he received a position as assistant in the Botanical Institute—at first in the Botanical Garden, and afterward in the Herbarium—and filled that office till his death. He also, at the suggestion of Minister von Altenstein, composed a little botanical text-book for the use of schools, in the introduction to which he laid down his general views on organization and systematics. A memorial of his botanical work was published shortly after his death by his friend and former colleague von Schlechtendahl, in Linnæa, in which, under the running title *De plantis in expeditione Romanzofiana observatis* (On the Plants observed in the Romanzoff Expedition), several of Chamisso's plants were familiarly described. A modest plant of the family of the unwilting amaranths (*Chamissoa*, Kunth) preserves his name in systematic botany. His favorite plants were those of the water, particularly the *Potamogetæ*.

Chamisso's discoveries on the voyage began when he descried, even on the English coast at Plymouth, a species (*Centaurea nigrescens*) which had escaped the local botanists. In several places, as at Teneriffe and in Brazil, he was prevented from making important collections by the rainy season, and in Chili by the burning summer heat; but he obtained nearly the whole of the flora of the Radak chain, and the coast of California, which had been rarely visited by botanists, afforded much that was new; among others, the papaver called after his fellow-voyager *Eschscholtzia californica*, the seeds of which he brought home with him, and the brilliant flowers of which still adorn our gardens. The islands of the Arctic Ocean, between America and Asia, furnished a rich spoil in their Alpine flora, which strongly reminded him of the Alpine meadows of Switzerland. So sharp and skilled had his vision become, which he had begun to train to the observation of natural objects three years before his journey, that, botanizing on Table Mountain at the Cape of Good Hope with Mundt, of Berlin, who was sojourning there, he found, as at Plymouth, several plants that had until then escaped notice.

Schlechtendahl can not sufficiently praise the magnanimous unselfishness with which Chamisso, after his return home, surrendered his specimens to be examined by other botanists who seemed better fitted by their studies to that work. Thus, he sent to the Swedish algologue, Agardh, a collection of algæ, among which was a rare double form found at the Cape, a living fucoid (*F. confervicola* or *Sphærococcus*) on a conferva (*C. mirabilis* or *hospita*). Agardh, who was a little too earnest a transformist, and believed that certain algæ could become animals, imagined that in this case the one form was changed into the other—a view which, true to his well-matured principles, Chamisso contested in a special memoir.*

As a reward for his earnest exertions, and also as a warning against too narrowly limiting the circle of possibilities in organic nature, Chamisso himself was destined to make one of the most remarkable discoveries in the region of metamorphism. This was in the case of the *Salpæ*, those soft, transparent organisms which, clinging to one another, swim over the sea in chains of from twenty to forty members. Besides the chains there are individual salpæ, but of two kinds, one of which bear traces in their organs of adherence of having been members of a chain, while the others do not. During a calm, on the voyage from Plymouth to Teneriffe, Chamisso made the surprising observation that the individual salpæ which have never belonged to a chain bear a progeny resembling the chain salpæ; while he found in the members of a chain young of forms agreeing with those of the single salpa. The salpæ of the chain, which produce single salpæ, are hermaphrodite; the single salpæ are asexual, and the chains are developed in them without fertilization, by inner budding. They thus alternate every two generations, one of which is sexual, and the other asexual and propagating itself by budding; and they are distinguished by other marks. To use Chamisso's figure, a salpa does not resemble its mother or its daughter, but its grandmother, its sisters, and its aunts. Chamisso called this kind of propagation that by alternating generations. So new and unprecedented was this discovery that, although Chamisso related it after his return in 1819, in a special Latin publication,† it either passed unheeded, or was stamped upon. But there came to Copenhagen, in 1842, a defender and champion of Chamisso's fame in J. Steenstrup, who discovered that the process of propagation by alternating generations such as Chamisso described was common to a series of organisms, including the *Medusæ* and *Strobilæ*, the *Cercariæ* and *Distomæ*, and the aphides or plant-lice, to which many others have since been added; so that the whole matter was cleared up in a trice. Johannes Müller's famous discoveries concerning the development of the echinoderms furnish a transition between the phenomena of alternation and those of metamorphosis as illustrated in the frogs and butterflies. The honor of having led the way to these discoveries belongs, as Steenstrup has expressly declared, to the accurate and ingenious investigator Chamisso.‡

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* Ein Zweifel und Zwei Algen (One Doubt and Two Sea-weeds), 1829.

† De animalibus quibusdam e classe vermium Linnæana in circumnavigatione terræ . . . observatis, etc. (On Certain Animals of the Linnæan Class of Worms observed in the Circumnavigation of the Earth.) Fasc. 1, De Salpa. Berlin, 1819.

‡ Steenstrup on Alternating Generations. Copenhagen, 1842.

Another important subject, with the discussion of which Chamisso was associated, likewise relates to the pelagic fauna, but also belongs as much to geology and physical geography as to biology. It is that of the origin of the co-called sunken islands or atolls of the south seas and the Indian Ocean. It has been recognized from the first that these islands are the work of organic architects, the coral polyps, which absorb lime from the sea-water and build their oceanic castles with it.

After Johann Reinhold's theory that the ring-walls were built by the polyps from the depths of the ocean, and Henrik Steffens's hypothesis of submarine craters, came Darwin's celebrated theory, which supposed that the corals were built upon a substructure already existing in the ocean-bottom which gradually subsided under a continuous volcanic action so as to keep the rising structure at about the same level; and after that the contradiction of it by Murray and Wyville Thomson, on the basis of observations made during the Challenger Expedition, which pointed to a rise of the substructure. Here comes in a fundamental observation with which Chamisso's name has been associated, to the effect that the coral animals, never moving away from the one spot to which they attach themselves, need a stirring sea to bring them food, oxygen, and lime. Hence an atoll will rise wherever there is a suitable foundation, at not too great depth, on which the polyps can fix themselves; and as they thrive better on the edge of their ring, where they are favored by wave-beats and currents than in the middle, a ring-wall will rise, which should be higher, as is the case, on the windward side, where the wave-motion is strongest. These facts have been put prominently forward in all the discussions that have been had on the subject; and Chamisso has been credited with having been the first person who observed and mentioned them. I am obliged to disclaim Chamisso's title to this honor. The observation was first ascribed to Chamisso by Darwin, who says, in his Coral Reefs, "The larger kinds of corals, 'which form rocks measuring several fathoms in thickness,' prefer, according to Chamisso, the most violent surfs"; and from Darwin's it has passed into other works. A study of Chamisso's writings will show that, while he acccurately examined and described the atolls petrographically, geognostically, and zoölogically, he never made that remark. Darwin's mistake originated in his attributing to Chamisso a remark which appears at the end of the third volume of Kotzebue's First Voyage (containing also Chamisso's Remarks and Observations), in an Appendix from other Authors, which, there is abundant evidence to show, was made not by him but by Eschscholtz.

"The coral reefs and islands of the great ocean," says Chamisso in Ansichten von der Pflanzenkunde und dem Pflanzenreiche, "are as much products of animal life as the peat-bogs are products of vegetable life." We get an idea of the comprehensiveness of his view of Nature when we consider the attention he gave, soon after his return from the voyage around the world, to so comparatively insignificant objects as the North German peat-bogs. The opinion, based upon an observation of Alexander von Humboldt, then prevailed, and was held by Leopold von Buch, that such bogs as that of Linum, near Berlin, contained remains of a sea-weed (*Fucus saccharinus*), and were, therefore, to be regarded as of marine origin. After an examination, which he began at Linum with Poggendorff and Friedrich Hoffmann, and continued alone at Rügen and along the Baltic coast, Chamisso supplied the proof that the sea had had no part, either in the interior or on the coast, in the formation of peat, and that no change in the relative level of land and water need be supposed to explain the process. Chamisso saw again at the peat-bog of Linum the *Kimming*, or mirage, which had prominently exhibited itself to him in the high north. He attached to this observation a less known remark, which I recollect having heard in Paul Erman's Lectures, that the mirage can be seen in vertical planes on long, straight, sunny walls, like the old city wall of Berlin between the Potsdam and Halle Gates.

Chamisso's zoölogical observations were by no means limited to the lower forms. He regarded the vertebrates of all latitudes with equally earnest attention—the flying-fish; the birds that rested on the Rurik; the whales, which he dreamed of taming and training to service; and the sea-lions, through a bellowing herd of which he walked fearlessly on St. George's Island. He made profound psychological observations on the monkeys that were taken on the Rurik. He also had an eye for extinct animals. A tusk which was dug up at Kotzebue Sound was referred by Cuvier in the *Ossements fossils*, on the evidence of his drawing and description, to the mammoth.

But, as we have already observed, Chamisso gave special attention on his voyage to the study of man himself. Of course, exact observations and determinations of the physical constitution of men coming up to present ideas on the subject were not to be expected from him, although he collected skulls; and he must have been overtaken many times in details by the growth of commerce in the last seventy years, and the more perfected methods of research, like anthropometry, plaster-molding, and photography. But he still stands the author who, through his distinction between the two chief provinces of the great ocean and a separate group of islands, first cast light on the mixture of peoples who dwell in the island world. Thus, according to Bastian, the distinction of Micronesia from Polynesia was first indicated by him, and, in the north, he furnished valuable data concerning the relationship of the Asiatic Chuckches and the American Eskimos.

The general result of his studies of history and nature, as he expresses it, is again opposed to the views now prevailing, in that he regarded man as very young on this old earth. But, although his anthropological views seem to be in many respects antiquated, his ethnographical sketches are of exceeding value in that he has lovingly and carefully given us a vivid and picturesque view of human conditions on the oceanic islands that can never be surpassed, for the simple reason that the original is irrecoverably lost. With prophetic view Chamisso predicted the annihilation of this endlessly charming culture by contact with the dreadful white man—a prediction which has been already to a large extent fulfilled. He knew well what he was doing when he described, drew, and made memorable what he could of customs and usages, religious ideas and superstitions, myths and songs, costumes and weapons, vessels and sea-tackle. And after his return he repeated, impressively and loudly, the advice that the threatened treasures that still remained should be saved at once. The poet is recognized in the pretty parable in which he clothed his lamentation: "All the keys to one of the most important problems which the history of the human race in its wanderings over the earth presents to us are being thrown by ourselves into the sea of oblivion at the very hour when they are given into our hands." Only in very recent times, when it has become almost too late, have we begun to move in the direction pointed out by his admonition.

Perhaps Chamisso was influenced by some of Rousseau's ideas in his extravagant admiration of the handsome, happy, easy-going men of the south sea islands, particularly of the Radak chain. He had not words enough to praise the native nobility of the men and the chaste grace of the songful women of Radak. He bitterly condemned the silly arrogance of the sham civilization that called these men savage. He contracted what by the taste of these days would be regarded as a somewhat sentimental friendship with an especially intelligent man, a castaway on one of the Radak Islands, who trusted himself upon the Rurik to be taken to his home on one of the Caroline Islands. Kadu, as he was called, who, however, left the ship when it touched the Radak Islands for the last time, plays an important part in Chamisso's reports, because he was able to give him information not too easily obtained otherwise on a number of questions, and Chamisso laments that he was deprived by the separation of the opportunity of being further instructed by him. Kadu rendered inestimable service in the linguistic researches which Chamisso pursued with extraordinary zeal and industry. Chamisso had a gift for languages, although he could not learn Russian, which he displayed in the ease with which he could come to an understanding with the men of different tribes who came on board the Rurik. His Bemerkungen und Ansichten contain full vocabularies of three Polynesian dialects, among them that of the Radak chain, and proofs of the Radak folk-poems, in which he found a solution of his own for the problem of phonetic transcription, which has been so much discussed since his time. He continued these studies at Luzon, where the Tagalic language (of the Malaysian group) had been reduced to writing, and collected a Tagalic library, which he held as one of his most valuable acquisitions. When his house at New Schöneberg was burned in 1822, after the lives of his family, this Tagalic library was the first thing he tried to save, and, to preserve it from future dangers of the kind, he presented it to the Royal Library. In unison with a conviction of the unity of the human race, he also in philology believed in a single origin for all languages, in striking contrast, as Max Müller has remarked to me in a letter, with his habit of emphasizing the specific in natural history.

A linguistic episode which Chamisso relates is, perhaps, even now of some current interest. The curious custom was in vogue in Tahiti of (on the accession of a new ruler and similar cases) extirpating words from the common (not the old liturgical) speech and replacing them with new ones. About the year 1800, Tameiameia, the King of the Sandwich Islands, likewise, on the birth of a son, invented an entirely new language, and began to introduce it. The newly formed words were not related to any roots in the current language, and even the particles were changed. It is said that some of the powerful chiefs, displeased with the movement, poisoned the child who was the occasion of it, and what had been undertaken on his birth was given up on his death. The old language was restored and the new one forgotten, so that Chamisso only found a few fragments of it. He learned just enough of the Hawaiian language to enable him to speak intelligibly with the natives concerning the most necessary matters, but made no attempt to commit it to writing. When he came to revise his Travels for a new edition, just before he was elected to the Academy, the Hawaiian language had become one of literature, and the murder of a prince was not needed to deliver it from an artificial rival. Publications enough had issued from the Hawaiian press to make a fundamental study of the language practicable. Wilhelm von Humboldt had begun, in the course of his great work on the Kawi language of Java, to cast light upon the Polynesian languages, when death called him away on the same day that Chamisso's election came up. The latter now thought he recognized a calling derived from his voyage and his earlier studies to devote his later efforts to making this field of linguistic research cultivable. He undertook to learn the Hawaiian language from the books which he had at hand, and assigned himself the task of preparing a grammar and dictionary of it.

We have thus gone around the circle of Chamisso's scientific work. From a profusion of single observations, remarks, and experiments only a small part of his peculiar activity can be illustrated here. Considering his activity as a whole, it must be conceded that his strength did not lie in the direction of strict theoretical analysis. This is not to be wondered at if we consider the condition of theoretical science in Germany at the time, when it was just beginning to recover from its enervating entanglement with philosophy. But the characteristic and really remarkable feature of Chamisso's scientific activity is his power of embracing the whole world of phenomena with the same love, freshness, and elasticity—from the stone that rung under his geological hammer; the hay, as he modestly named his dried favorites; the sea-worm, which revealed to him one of its most wonderful mysteries; to that noblest production of Nature, as man represents himself to objective research, whether considered as a single being related to the animals, as a tool-making, fire-using, social creature, or, in his highest expression of speech. With sound, lively sense, with always ready energy, Chamisso stands before the things of Nature, exercises unreservedly every kind of observation, and forms his conceptions without prepossession and with strict limitation to the actually known. He was thus, although his monographs may have been overtaken or his general views have fallen behind those of the present day, a complete naturalist in the best sense of the word, and that at a time when such men had to be looked for through Germany as with a candle.

Many of those who go by his marble image in the future will recall "Peter Schlemil," "Schloss Boncourt," and Salas y Gomez. A few will think of the botanist and ethnologist Chamisso, of the salpæ and the coral islands. Greeting from their inmost hearts the few will bow to him who like him, in an iron age, and in the midst of the striving after the real, have kept in disposition, fancy, and spirit a place for all that is of man, for the ideal, and the beautiful.—*Translated for The Popular Science Monthly from the Deutsche Rundschau.*

CORRESPONDENCE.

THE INFLUENCE OF SPENCER'S PHILOSOPHY.

[TRANSLATION.]

Editor Popular Science Monthly:

SIR: Being a diligent reader of the review which you direct, and which I consider one of the best exponents of scientific progress, and spending a short time in this city, I have read with satisfaction in the number for August the article entitled Mr. Spencer's Place in Philosophy. Only ignorance of the influence which the scientific philosophy of Mr. Spencer is exercising in the modern world, and of the place which philosophy in general occupies in the order of human knowledge, could have permitted the editor of the New York Times to question the position which the superior intelligence of the English philosopher has conquered.

While I do not know what the respondents of the writer who calls himself "Outsider" have brought forward, and while I have no books at hand and can only follow the tone of your reply, I hope I may be permitted to indicate a few of the points in which specialists in different sciences have been anticipated by Mr. Spencer.

When he wrote his Principles of Biology, organic chemistry was in its infancy: Gerhart had not yet occupied himself with the serial classification; Kekulé had not yet discussed the molecular constitution of the carbon compounds; and the mind of the philosopher was still only occupied with the application of mechanical principles. Nevertheless he was able to anticipate the true function of organic carbon and the peculiar chemical properties of nitrogen. Many chemists were not agreed respecting the importance to be ascribed to nitrogen in vital reactions. But the inertness of that body; its strange manner of entering into combination; the inverse reactions which it provokes; the variations of its equilibrium with the proportions in which it forms part of compounds; the different modes of its behavior under the influence of electricity; the personality, as we might say, which it possesses in every reaction; and, especially, the difficulties which chemists like Schoenbein, Deville, Munst, Marcam, and Berthelot have met in accounting for the method of its entering into combinations to form vegetable substances, now proceeding from the air and now from fertilizers—all these features Mr. Spencer's paper assigned to this body and illustrated before chemical studies demonstrated them. We will not concern ourselves with the later spectroscopic observations, nor with the discussions, of which the two very different spectral systems that nitrogen presents have been the occasion, for they are not in question here.

Until a recent date, chemists held to a conception of the atom not widely different from that which was accepted in the time of Epicurus, and his atoms were identical with those which Dalton conceived. But Mr. Spencer, before William Crookes had resolved yttrium into its more simple components, before he conceived the idea of protyle, had spoken of the *physical atoms that constitute the chemical atom.*

If he who calls himself "Outsider" had read a letter of Mr. Spencer's addressed to the North American Review, which was inserted at the end of the first volume of the French edition of the Principles of Biology, in which he declared himself against the theory of spontaneous generation, not only as it then existed among students, but also as Haeckel afterward defined it in his theory of perigenesis of the plastidules, he would have been convinced that the philosopher had anticipated the results obtained by the latest biological studies and the conceptions of the chemists of to-day on the complexity of organic molecules.

Mr. Darwin introduced an epoch in the history of thought. But, before the Origin of Species appeared, Mr. Spencer had formulated the doctrine of transformism in a manner so universal that the truths demonstrated by Mr. Darwin are seen to be a necessary consequence of the laws of evolution.

The opinions of the philosopher on the constitution and mechanical function of the nervous system, as well as respecting the office which is filled by the system of the great sympathetic in the higher animals, occupy a distinguished place in modern physiology.

In the subjective analysis of thought, Mr. Spencer has reached a point that no one had attained till his time; and his incontrovertible criticism of the concepts of Kant, and of the ideas of time and space, reveals a profundity of intelligence which was not surpassed in Aristotle.

His social studies are instructive to the statesmen of the present. His criticisms of the parliamentary systems of Europe have modified the ideas of political men. The recrudescence of the military *régime*, with all its consequences, was foreseen by Mr. Spencer; the exposure of the absurdities of much modern law making by constituted states is his work; no one has demonstrated as he has done the wonderful power of individual initiative as opposed to the Attila's horse of state intervention; the force of German socialism as a consequence of the socialism of the state imposed by Herr Bismarck was foreseen and censured by the philosopher. The New Toryism and the Coming Slavery which he foresaw, already exist in Europe. The pernicious consequences of protectionism, which have occasioned great commercial crises in the old continent, but which the United States have escaped suffering only because the economical errors of the system are in great part balanced by the magnificent political organization they possess and the conditions of the environment and the ethnical relations that help you, were all pointed out in the sociological works of the philosopher. What authority can be seriously opposed in this day to the arguments of the socialistic party in its contentions against the present organization of society, except we invoke the sociological principles established by Herbert Spencer?

It remains, in concluding this letter, to point to a fact which relates particularly to my country, Spain. Before the doctrines of the philosopher had spread among the Spanish thinkers, radical partisans had no faith except in the processes of the French Revolution and in the Declaration of Rights written in the Constitution, the precepts of which, however, were not complied with in practice. But to-day, the radical Prof. Salmeron, as well as the conservative D. Antonio Canovas del Castillo, invoke only the principles of the laws of evolution. In no other principle has been founded the changed course of conduct pursued by the eminent tribune, Don Emilio Castelar, during the last fifteen years. I remain your obedient servant,

Gaston A. Cuadrados,
Pharmacist-major in the
Spanish Army in Cuba.

New York, *July*, 1890.

A DEFENSE OF MECHANICAL TEACHING.

Editor Popular Science Monthly:

Dear Sir: In the November Popular Science Monthly I notice a letter from Anna Chapin Ray in which some educational methods, so called, are severely criticised. While I acknowledge a certain justice in the criticism upon the particular points cited, I beg leave to suggest that possibly a closer observation of school work might show reasons for the line of action indicated in the different instances. To designate pupils by numbers instead of by their names does seem mechanical, to say the least; but when we remember that a teacher has perhaps eighty children, with a recitation period of not more than thirty or forty minutes, and when we also remember that it takes less time to count eighty than it does to pronounce eighty names, we can hardly wonder that the teacher resorts to that means which will secure her the most time for actual class work. The teacher is not responsible for being driven to this. School boards are responsible, and we should understand that it is impossible for any teacher to do natural educational work under such conditions.

I have not yet considered the subject of writing to the accompaniment of music sufficiently to give a decided opinion upon this question, but I think I can see that music may be a means of obtaining certain desirable ends in this connection. It may be the means of securing regularity, precision, uniformity, and rapidity of action, and so may be of value. It does not follow that, if music is used as a means in teaching writing, those pupils who may become accountants should do their work to the accompaniment of music. The music is only a means to an end, which in this case is skill in writing. If by means of music this end be attained with a less outlay of time and energy than it could otherwise be secured, it seems to me that the teacher shows wisdom in using it. As soon as the end is gained, the means, of course, can and will be dispensed with. Whether the use of music here be judicious or not, I think that no one will question the importance of securing uniformity of action upon the part of pupils. In a writing-lesson, as in other lessons, it is well that the pupils all observe a direction at the same time. If every child were allowed the privilege of being a few moments behind every other, your correspondent can see that very little work would really be done. Concerted action on the part of children is desirable; by means of it the more impetuous pupils of the class are restrained, while slower ones are brought forward more rapidly than they otherwise would advance.

Class interest, and indeed all social interest, is based either directly or indirectly upon concerted action. It does not render the pupil less capable of acting alone when occasion requires, and it does enable him to adapt his actions to those of another person when such adaptation is necessary, as we find it to be more or less in all the relations of life.

In regard to the book work, I can also understand that a teacher might very wisely take means to prevent the children from anticipating the work on hand. If original work on the part of the pupil were required, it would be well that he should not make use of the matter contained in his book, as the end in view would certainly thereby be defeated.

Again, I should like to suggest that the line of action pursued by the different teachers in the different instances stated can not possibly be considered as "methods" of instruction; they are at best but crude plans employed by the teachers for the purpose of securing certain ends. Method in instruction implies the uniform observation of educational principles; while those plans mentioned very often illustrate in the teachers an excess of that individuality which your correspondent claims for the pupils. If the child is to be individual in his actions, the teacher should certainly be so. The fault in the instruction in our public schools at present, however, is not a lack of individuality, but rather a lack of uniformity. If our teachers depended a little less upon their own individual impulses, and more upon the recognized principles of education, we should probably have fewer imperfect plans to criticise, and would secure better results in our work.

We have not to complain of a "craze" for carrying methods to extremes so much as a "craze" for individual prominence, which results in somewhat absurd plans of procedure that must be abandoned as soon as their novelty wears away. Nothing will correct this weakness so completely as the uniform training of teachers in accordance with recognized psychological principles. When this is secured, the observers of school work will at least do teachers the justice to suppose that they have excellent reasons for what may appear to the uninitiated to be mere erratic action. Yours truly,

Margaret K. Smith.

Oswego, N. Y., *October* 24, 1890.

UNNATURAL READING.

Editor Popular Science Monthly:

Sir: In your issue of November appears a letter from A. C. Ray, calling attention to the method of teaching reading in vogue in our public schools. To quote the writer's own language, "Children are taught to read without spelling, recognizing each word by its appearance, and learning it as a detached fact."

Your correspondent then goes on to show the unnaturalness of the "natural method" so called. Permit me to say that I personally thank the writer for having had the courage to bring this matter to the attention of your readers. The present natural method of teaching children to read is indeed an absurdity, and it is difficult to understand the reason and the authority upon which such a system has been adopted.

My little girl is attending a grammar school in Cambridge, Mass., which has the reputation of being a very good one. My child is in the fifth class, and I am informed by the teacher that this class offers greater difficulties to the average pupil than any of the higher classes. Night after night I have the pleasure of rehearsing with her the writing-lesson of the day. Now, how does the child learn to read! The school uses Swinton's History and Geography. From this book the teacher, no doubt acting under instructions, reads daily with the children, and then dictates to them the principal words contained in the paragraphs they have been reading. I beg to be understood that the words are dictated and written by the children *as they are found* in the text-book—i. e., the verbs not in the infinitive mood, but in any of the several tenses; nouns either in the singular or plural; all in confusion. I will give here a few of the words found in one of the lessons: Sachem, aurora borealis, Cheyenne City, arctic, eider-down, Phœnix, Indianapolis, Indian dialect, Latin language, French or Indian, Greek language, German language, Latin language, compound English-Greek.

It will be observed that these words represent a fine collection taken from several old as well as modern languages. No explanation is given by the teacher concerning the derivation of the words; if she thinks well of it, she will tell the children what the meaning of such a word is, but all the rest is a *tabula rasa* to the pupils.

No doubt some people will not believe me when I assert that, though my child has been attending school four years, has been studying writing and reading for the same time, she has never been taught the difference between a vowel and a consonant, and, consequently, she is ignorant of the very tools she is called upon to work with.

It seems but too simple a thing to call attention to the numerous recurring unchangeable prefixes, affixes, endings, etc.; such, for instance, as "ious," "ive," "able," "ation," etc., or to tell them that a certain grouping of characters as a rule produces such and such sounds, all of which would materially assist the pupils and save them hours of laborious work. But no, let them grope in utter darkness and recognize each word by its appearance! If that is a correct way of teaching children reading, why don't you apply the same method to teaching arithmetic? As the English language contains about forty thousand words, independently of numerous derivatives, compounds, and grammatical formations, the idea of teaching children reading by recognizing each word by its appearance is indeed absurd.

The evil effects of such a system are self-evident, but the means of overcoming the evil are not so apparent, and after a good deal of consideration I have thought best to apply to The Popular Science Monthly for assistance. No doubt many fathers and mothers will take a deep interest in this matter touching the education of their offspring, and as it is useless for an individual to go to the several school boards, laying his or her grievances before them, I suggest that through the agency of The Popular Science Monthly an association may be formed of such people as are interested in the education of children; that the aim of such association be united action to bring sufficient pressure to bear upon the several school boards to modify or abolish the method now used in the public schools to teach children reading, and to consider ways and means to best accomplish this purpose.

I shall be glad to hear from other people in this matter. Victor M. Berthold.

Cambridgeport, Mass., *October* 27, 1890.

EDITOR'S TABLE.

A DOUBTFUL PROP OF MORALITY.

VERY persistent are the attacks of the supporters of an effete philosophy upon those intellectual views which are renewing the life of the world and enabling the human mind to shake off the burden of spiritual tyranny. Some of our readers may remember an article which we devoted a couple of years ago to a novel by a celebrated member of the French Academy, M. Octave Feuillet, the leading character in which was a young woman who had been brought up by a philosophical uncle in complete emancipation from theological beliefs, and who took, in the most natural way in the world—as the direct result, we are given to understand, of her acceptance of modern thought, and particularly of the Darwinian theory—to a career of monstrous and cold-blooded villainy. Her uncle was a benevolent old gentleman; but the evolution philosophy showed its perfect result in the niece, who had imbibed it in her very earliest years. This fine example of a "novel with a purpose" appeared first in the columns of the Revue des Deux Mondes; and to-day we find in the same periodical no less striking an example of a drama with a purpose, the author this time being M. George Duruy, and the title of his production Ni Dieu ni Maître. In this work the philosophical and philanthropical uncle of M. Feuillet's creation is replaced by a father—an eminent medical man—of similar views and similar character, who has brought up his own two children in complete independence of priestly control, and who, in return for all the affection he has lavished upon them, reaps a harvest of selfishness and ingratitude. Without being as utterly depraved as the delightful heroine of M. Feuillet's romance, they are mere creatures of pleasure and vanity, and when their poor father falls into ill-health and comparative poverty, instead of sympathizing with and aiding him, they have nothing for him but complaints and reproaches. The uncle in M. Feuillet's story and the father in M. Duruy's, it is noticeable, are both physicians, these authors paying the medical profession the compliment of thinking that the study and practice of medicine are particularly favorable to a philosophic cast of mind. M. Duruy throws in an interesting minor character in the person of a smart young physician, who had studied under the elder one, and who, in the days of the latter's prosperity, had become engaged to his daughter, but who, having got possession of the lucrative practice which the elder physician, through failing health, had been compelled to hand over to him, throws the daughter overboard without the slightest compunction. This young man, too, is offered to us as a shining example of what free-thought means when reduced to practice. Tricked out as these fictitious narratives are in all the graces of style that literary art can command, they are doubtless adapted to have an effect on a certain class of minds. Rich devotees of luxurious superstition will be greatly edified by the demonstration that not common sense but ecclesiastical authority is to determine all questions of education and conduct; and timorous souls in general will be glad to find that they are justified in refraining from any independent exercise of their minds upon moral questions. Others, among whom we count ourselves, find more of "purpose" than of honesty in these representations: to us they do not show the true working out either of the ancient or of the modern principles of morality, and we propose once more to show why.

One fact is incontrovertible, let literary or other reactionists say what they will, and that is, that in a moral point of view the world is vastly better to-day than it was centuries ago. The world has had its ages of faith; the world has now its age of comparative reason. If we want poisoners who could outdo the performances of M. Feuillet's young woman in La Morte, we go to the ages of faith, we seek them in papal courts amid cardinals and their relatives. If we want filial ingratitude in far more hideous forms than M. Duruy has undertaken to paint, the same society, in the same age, will furnish it. The true middle age is shown in the works it has produced, in the Decameron of Boccaccio and the Canterbury Tales of Chaucer, in which lust and superstition walk hand in hand. Charles Reade has also given a powerful picture of it in his acknowledged masterpiece, The Cloister and the Hearth. Let any one compare the condition of Europe at that time with its condition to-day, and then say whether the material, moral, and intellectual interests of mankind have not gained immensely by the emancipation of thought and the weakening of authority.

But if we look at the case presented to us by M. Duruy in Ni Dieu ni Maître, we shall see how very ill he conceives the duties of a really enlightened father toward his children. His Pierre Nogaret, a physician in the very front rank of his profession, with an annual income of over a hundred thousand francs, has two children, Maurice and Adrienne, whose mother is dead. Instead of interesting himself in their education, he turns them over to hired teachers, and never asks what progress they are making or how their characters are developing. In a conversation between the brother and sister, the former is made to say: "I have grown up I don't know how; no one has ever told me what is right or what is wrong, and I can't find it out entirely by myself. Papa made me take up the study of the sciences, but he never took the trouble to see whether I learned anything, and now there are moments when I feel that I am not worth a rush." The sister has very much the same account to give of her education; and both brother and sister were brought up, as the story shows, in very extravagant habits. Both were launched into the world of fashion without any effort being made to guard them against the temptations to which they were thus exposed.

Now why, we ask, should this be offered to us as an example of education upon modern principles? Why should a man, because he has embraced, let us say, evolutionary views, allow the education of his children to proceed at hap-hazard? Why should such a man leave his children unprotected against the seductions of a vitiated society? Why should he allow their home affections to be weakened and stunted by a senseless immersion in social gayeties? If a clever writer wishes to do justice to the great question which MM. Feuillet and Duruy approach in so partisan a spirit, let him draw a picture of a man who has discarded superstition because of its demonstrated falsity, who has embraced the principles and results of science because of their demonstrated truth, and whose aim it is to do in his lifetime the utmost amount of good that circumstances permit. Then let this man have in conjunction with these elevated views a certain amount of common sense. If he has children whom he sincerely loves—and such love is not an unreasonable postulate in a father—let him recognize that, if they are to dispense with the conventional aids to right conduct, they must have others in their place, and let him duly cultivate their moral and emotional nature. Let him refrain from placing them, or allowing them to be placed, in circumstances of too great temptation. Let him carefully guard against their becoming the slaves of luxury and idleness. Let him not give them as associates persons whose principles of action are the very reverse of his own. Let him not betroth his daughter to an intriguing jackanapes who avows himself destitute of every principle save selfish ambition. Let his love for his children be manifested otherwise than by keeping up an expensive establishment. If these conditions be observed, we shall have a man who, point for point, shall do just what Pierre Nogaret *did not do*, and refrain from doing what Pierre Nogaret *did do*. And then let it be shown, if it can, in consonance with recognized principles of human nature, how such methods of training and discipline lead directly to ill-regulated and frivolous lives on the part of the philosopher's children. Let us see just how it comes about that natural affection dies out in the atmosphere of such a philosopher's household. Let us be made to feel in a powerful manner the chasm that is left in the philosopher's family life by the absence of the priestly element. It is easy to make men of straw and then knock them over or treat them with any other indignity; but the task is not one that is worthy of a literary artist of any ability. In M. Feuillet's romance there was some attempt made to show how the doctrine of the survival of the fittest naturally inspired thoughts of murder in the female mind. We did not think much of the proffered demonstration, but it made at least a decent show of respect for the requirements of logic. In M. Duruy's drama such show of respect is wholly lacking. His philosopher entirely neglects his children's moral education, brings them up in expensive, luxurious, and idle habits, exposes them to all the temptations of a morally worthless society, and then, when they have been—not wholly, but largely—perverted by the evil influences around them, we are asked to lay the whole blame of their perversion upon their father's heterodox views, and to draw a sweeping conclusion as to the ruinous effects on morality of modern philosophy in general.

The unprejudiced reader will not draw any such conclusion. The conclusion that may be drawn is that no set of merely speculative opinions offers any guarantee for satisfactory moral development apart from a careful observance of the conditions on which the formation of sound, moral character depends. It is one thing to adopt the Darwinian theory; it is quite another to know how to bring up children: and some Darwinians, or alleged Darwinians, make nearly as poor a business of it as some clergymen. It is not the mold in which a man's opinions have run that makes him a competent moral educator; it is the amount of earnestness he throws into moral questions and the amount of practical good sense that he brings to bear in order to insure that the children committed to his charge shall be well grounded in sound moral principles and habits. The son of M. Duruy's philosopher tells his sister that if ever he succeeds in capturing a woman with a big fortune and has children, she will see how he will "stuff them with religion." Alas! the recipe is not a new one. How many children have been "stuffed with religion," only to grow up exceptionally bad! The children who do best are the children of parents whose lives bear still more powerful testimony than their words to right principles, and who are not too busy to take a constant interest in their children's education, moral as well as intellectual. To ask the world to go back to mediævalism in order to save morals from destruction is asking too much. That system has been tried and found wanting, and the world is now seeking another and a better foundation for morals. Doubtless many rush forward and grasp at the new opinions without realizing all that they involve and demand. The age is one of unsettlement; but it is one, unmistakably, of progress; and when our methods of education have been adapted to the new truths now in course of formulation, there will be no reason to regret the props and stays and leading-strings that helped to steady the morality of the past.

HUMAN SELECTION.

We published in our last number an interesting article under the above title, by Mr. Alfred Russel Wallace. Mr. Wallace is much concerned over the fact that modern sooiety is being recruited chiefly from the ranks of its less worthy members, and is thus undergoing a constant process of deterioration. Under any form of government this would be a serious danger, but, where democratic institutions prevail, it forebodes, unless it can be arrested, nothing less than social dissolution. The more favored classes marry late, for the most part, if at all. Their children are comparatively few. The improvident and worthless marry early, without the least regard for consequences, and flood the community with their degenerate offspring. That is the situation as described by certain writers, and the remedies proposed are many and varied. One writer wants restrictions placed on marriage, whether of a physical or merely legal kind we are not sure. From the very careful manner in which Mr. Wallace touches upon this suggestion, we rather fancy that something radical in the way of surgery has been proposed. Another authority, who ought to be better advised, wishes to substitute a very high-toned system of concubinage for the present institution of marriage, so that the female sex may be able to select worthy sires for the children they are disposed to bear. Another would have premiums given to young couples of unexceptionable strain, physical, mental, and moral, so that they may start early in life to contribute good citizens to the commonwealth. Mr. Wallace does not look upon any of these plans with approval, and rightly pronounces the second "detestable." He thinks, for his own part, that we ought to have an economically reformed society *a little* after Mr. Bellamy's ideas, and that, if we had, the women might be trusted to take care of the future of the race.

If Mr. Bellamy had done more than dream a very incoherent dream, we might think that Mr. Wallace had struck into the right path. We believe in female selection as an influence destined to be very potent in the future, but we do not look to any such scheme as Mr. Bellamy's to bring it into play. It is being brought into play now through the growing independence and intelligence of women, and there is no doubt at all that, as women are more and more trained to practical usefulness, not only in the family but in the business world, they will consult both their own dignity and the interests of posterity more than they have hitherto done in their acceptance of the married state.

We are not disposed to consider the situation quite so serious as Mr. Wallace describes it; but doubtless there is some room for apprehension as to the future, and, if we might venture to make a suggestion in our turn, it would be that our troubles, such as they are, largely arise from over-legislation, leading to a hurtful decline in the sense of individual responsibility, and from altogether too weak methods of dealing with crime and pauperism. On the former point we have often dilated, and shall not do so further on the present occasion. On the latter point we may remark that nothing can possibly be more obvious than the necessity of isolating—permanently if necessary—the anti-social from the social members of society. In dealing with contagious diseases we carry out a rigorous system of isolation, and maintain it just as long as the danger of infection lasts. Criminals we imprison for a time, and then turn loose to prey anew upon society and beget offspring in their own depraved image. Paupers and various grades of helpless people we assist to support, without imposing any check upon their reproductive activity. All this is very foolish. A man is either able to maintain himself or he is not. If he is not, and declares himself not to be by the systematic acceptance of alms, then society may reasonably declare that he is not fit to found or control a family, and he should henceforth be assisted under such conditions and restrictions as should at least prevent him from casting new burdens upon society. If we could stop our miserable political (so called) wranglings long enough to take a common-sense view of the situation and become really interested in plans for its amelioration, the difficulties would not be found at all insuperable. Fit for civil rights or unfit for civil rights?—that is the question to be applied to every member of the community. If we persist, through sheer indolence and love for all that is paltry in the rivalry of parties and the squabbles of public men, in according civil rights to those who do not merit them through an active co-operation in the industrial life of the community, there is serious trouble in store for us. We might as well voluntarily take diseased persons into our households as keep morally and economically diseased persons on the roll of our citizens. What the latter want is control and segregation at whatever momentary cost. We simply recommend a quarantine that society has the full right to exercise. It would be cheaper at once to give rations to these people than to allow them to subsist on occasional charity and occasional stealings, while seriously interfering with the hygienic condition of the community, to say nothing of perpetuating their kind. Just how they should be dealt with when separated, what work should be exacted in return for maintenance, what educational measures should be adopted—these are questions for later consideration. The "human selection" that is required is primarily a selection that will put aside those members of society who in moral character or in the power of self-help fall below the requirements of decent living. This can be carried out as soon as we have sense enough to attempt it; and when once such a separation has been effected, and we have no longer in the heart of society a perennial spring of baseness and incapacity, the march of improvement in all directions will be rapid; while year by year the burden thus assumed by the state will diminish.

ANNOUNCEMENT.

We have the pleasure of putting before our readers in this issue of the Monthly the first of a series of articles which will give a comprehensive view of the evolution of each of the great manufacturing industries in America since the time of Columbus. They will be written in the popular style which has always characterized the Monthly, avoiding mere technical details and wearisome columns of statistics. At the same time, the writers have had long acquaintance with the practical side of the industries which they describe, and this complete command of their subjects enables them to present just those features which the general reader demands. Mr. William F. Durfee, who opens the series with an article in the present number, is known to the iron and steel men all over the country as a man of wide experience in the building and operation of iron and steel works, and is at present General Manager of the Pennsylvania Diamond Drill and Manufacturing Company. Our history of the cotton manufacture will be furnished by Mr. Edward Atkinson, who needs no introduction to the readers of this magazine. Mr. S. N. D. North, Secretary of the National Association of Wool Manufacturers, is the author of our account of the woolen manufacture. The development of glass-making will be described by Prof. C.

Hanford Henderson, whose illustrated articles in the Monthly on the present methods of this industry have been widely read. Articles on the Silk, Paper, Pottery, Shoe and Leather, Agricultural Machinery, and Ship-building industries will be furnished by equally competent hands. In describing the methods and the implements and constructions used in manufacturing, a picture is often better than pages of words; accordingly, this series will be fully illustrated. For the account of the iron and steel industry alone, sixty-eight engravings have been prepared. It will be one of the objects of the coming World's Fair to show the most important manufacturing processes of the present day in operation, and for comparison with these the methods used in other countries when Columbus discovered the New World. In view of the wide attention that will be thus drawn to the past and present of our great industries, we feel that we can not offer our readers anything more acceptable at the present time than the series above outlined. The wonderful increase in the quantity of goods that one man's labor will turn out, the improvement in their quality, the reduction of the cost of manufacture together with the steady rise in wages during the period covered by these articles, are all due to the aid which science has afforded to the world's workers, and this is only a fraction of the field in which the influence of this great agency is active.

LITERARY NOTICES.

The Principles of Psychology. By William James. American Science Series, Advanced Course. In two vols. New York: Henry Holt & Co. Price, $6.

Prof. James is Professor of Psychology in Harvard University, and this work embodies his class-room instruction in that subject. It is a large work. The first volume contains 689 pages and the second 704 pages. The type is admirable and the illustrations are fresh and well adapted to their purpose. The author says in the preface that he has throughout kept close to the point of view of natural science. He rejects both the associationist and spiritualist theories. His ground is that thoughts and feelings exist and are vehicles of knowledge, and that Psychology, when she has ascertained the empirical correlation of the various sorts of thought or feeling with definite conditions of brain, can go no further. By attempting to explain thought and feeling as products of something deeper, she becomes metaphysical, and Mr. James claims that in dealing with psychology he is strictly a positivist—indeed, this is the only feature of the work for which he claims originality. The author says it is "a mass of descriptive details running out into queries which only a Metaphysics alive to the weight of her task can hope successfully to deal with. That will perhaps be centuries hence; and meanwhile the best mark of health that a science can show is this unfinished seeming front." It is thus seen that although Mr. James deals with the science of psychology as a positivist, he still has faith in metaphysics, and it is this circumstance, it seems to us, that gives the work its most characteristic quality. His style, which is always clear and forcible, is never so brilliant as when he is discussing metaphysical questions. In stating the various theories of the different schools of philosophy he does not conceal his own preferences. Indeed, he is too much in earnest in his beliefs not to be a partisan. And being by descent both a metaphysician and rhetorician, while his science is more of to-day, his inherited tendencies now and then get the better of his scientific judgment.

In Chapter I, On the Scope of Psychology, Mr. James limits his field of inquiry by taking as his criterion of mind "the pursuance of future ends and the choice of means for their attainment." This view answers his purpose much better than would a nearer approach to the "point of view of natural science." The scientific psychologist usually begins with the earliest phenomena of consciousness and the first traces of nervous organization, and uses his earlier results to explain the more complex phenomena encountered later on in his inquiries. But Mr. James is catholic enough to say that "the boundary line of the mental is certainly vague. It is better not to be pedantic, but to let the science be as vague as its subject, and include such phenomena [instinctive and reflex acts of self-preservation] if by so doing we can throw any light on the main business in hand." He recognizes that at a certain stage in every science vagueness best consists with fertility, and quotes in illustration the Spencerian formula that life consists in "the adjustment of inner to outer relations," which he says has done much real service in psychology though it is "vagueness incarnate." He further says that "because it takes into account the fact that minds inhabit environments which act on them and on which they react; because, in short, it takes mind in the midst of all its concrete relations, it is immensely more fertile than the old-fashioned rational psychology which treated the soul as a detached existent, sufficient unto itself, and assumed to consider only its nature and properties. I shall, therefore, feel free to make any sallies into zoölogy or into pure nerve-physiology which may seem instructive for our purposes." The whole book, we are told, will be more or less a proof of the proposition that the *brain* is the one immediate bodily condition of the mental operations.

Accordingly, Chapter II treats through 78 pages of the Functions of the Brain, and Chapter III, of over 20 pages, considers the General Conditions of Brain Activity. These two chapters embody the latest assured results of experiment and observation, along with much comment and elucidation, and are very interesting and instructive. In Chapter IV the subject of Habit is dealt with in a most practical and impressive manner. The author supports his statements by liberal quotations from Dr. Carpenter's Mental Physiology. He closes with six or seven pages upon the Ethical Implications of the Law of Habit, addressed chiefly to the young, and bearing on the formation of character. Chapter V, on the Automatic Theory, and Chapter VI, on Mind-stuff, are lively, controversial, theoretical, all-sided, and strikingly display both the author's gifts of expression and peculiarities of method. Beginners are warned against several chapters in the book as too metaphysical, the one on Mind-stuff among them. If the trusting neophyte could read this chapter understandingly, it is hard to imagine the state of mind produced in him by the concluding paragraph, wherein all the points that have just been so conclusively refuted are affirmed to be, in the present state of our knowledge, the only ground of a scientific psychology. This backing and filling seem very odd in a text-book; but the author evidently can not help it. His aptitudes and tendencies are too strong to be resisted. And perhaps this non-committal, bantering, disputatious way of presenting all sides of the subject is the best possible one for the author's purpose as a teacher.

Chapter VII, on The Methods and Snares of Psychology, and Chapter VIII, on The Relations of Mind to Other Things, are also too difficult for beginners. They treat of the "outer world of objects and relations to which the brain states correspond."

In Chapter IX, on The Stream of Thought, the author enters upon the exposition of mind from within, or subjective psychology. Instead of adopting the synthetic method, and beginning, as is usual, with sensations, he begins with the process of thinking, which is treated analytically. He rejects the idea that because sensations are the simplest things they should be taken up first, and affirms that "the only thing which Psychology has a right to postulate at the outset is the fact of thinking itself, and that must first be taken up and analyzed." In this chapter he treats the subject of consciousness in a general way, and in Chapter X he discusses The Consciousness of Self. More than half of this long chapter of 110 pages is devoted to Pure Self, and treats of the Spiritualist Theory, the Associationist Theory, and the Transcendentalist Theory. He winds up the section upon The Soul Theory with the following words: "My final conclusion, then, about the substantial soul is that it explains nothing and guarantees nothing. Its successive thoughts are the only intelligible and verifiable things about it, and definitely to ascertain the correlations of these with brain-processes is as much as Psychology can empirically do."

One section of this chapter treats of The Mutations of Self, both normal and abnormal. The abnormal alterations are classed as

—(1) insane delusions; (2) alternating selves; (3) mediumships or possessions, and their discussion is popular, anecdotal, and tolerant, as becomes a member of the Society of Psychical Research. Mr. James tries to interpret the phenomena of mediumship. He speculates on the brain-condition during perversions of personality, and says "we must suppose the brain capable of successively changing all its modes of action, and abandoning the use for the time being of whole sets of well-organized association paths. And not only this, but we must admit that organized systems of paths can be thrown out of gear with others so that the processes in one system give rise to one consciousness and those of another system to another *simultaneously* existing consciousness."

Chapter XI, on Attention, discusses the question whether this is a faculty or a resultant—a cause or an effect. The author accuses the psychologists of the English empiricist school, naming Locke, Hume, Hartley, the Mills, and Spencer, of neglecting to notice it at all, and explains the motive of this ignoring by saying that "these writers are bent on showing how the higher faculties of the mind are pure products of 'experience'; and experience is supposed to be of something simply *given*. Attention, implying a degree of reactive spontaneity, would seem to break through the circle of pure receptivity which constitutes 'experience,' and hence must not be spoken of under penalty of interfering with the smoothness of the tale." The following extracts from his summary of the chapter may be taken as a fair sample of his style, and of his mode of dealing with subjects.

Mr. James says that he inclines to the cause-theory; but he also says that, "as regards immediate sensorial attention, hardly any one is tempted to regard it as anything but an effect." And, again: "Derived attention, where there is no bodily effort, seems also most plausibly to be a mere effect." And, again: "Even where the attention is voluntary it is possible to conceive of it as an effect and not a cause, a product and not an agent." Viewing it thus he says: "The stream of our thought is like a river. On the whole, easy flowing predominates in it, the drift of things is with the pull of gravity, and effortless attention is the rule. But at intervals an obstruction, a set-back, a log-jam occurs, stops the current, creates an eddy, and makes things temporarily move the other way. If a real river could feel these eddies and set-backs as places of effort, 'I am here flowing,' it would say, 'in the direction of greatest resistance. My effort is what enables me to perform this feat.' . . . The agent would all the while be the total downward drift of the rest of the water, forcing *some* of it upward in this spot. . . . Just so with our voluntary acts of attention. They are momentary arrests, coupled with a peculiar feeling of portions of the stream. . . . But the feeling of effort may be an accompaniment more or less superfluous, and no more contribute to the result than the pain in a man's finger when a hammer falls on it contributes to the hammer's weight. Thus our notion that our effort in attending is an original faculty, of which brain and mind are the seat, may be an abject superstition. Attention may have to go like many a faculty once deemed essential. It may be an excrescence on psychology. No need of it to drag ideas before consciousness or fix them, when we see how perfectly they drag and fix each other there."

Then, after this persuasive statement of the effect-theory, he gives the other side a chance by answering the question as to "what the effort to attend would effect if it were an original force." "It would deepen and prolong the stay in consciousness of innumerable ideas which else would fade more quickly away. The delay thus gained might not be more than a second in duration—but that second might be *critical;* for in the constant rising and falling of considerations in the mind, where two associated systems of them are nearly in equilibrium, it is often a matter of but a second, more or less, of attention at the outset, whether one system shall gain force to occupy the field and develop itself, and exclude the other, or be excluded itself by the other. When developed it may make us act, and that act may seal our doom. The whole feeling of reality, the whole sting and excitement of our voluntary life, depend on our sense that in it things are *really being decided* from one moment to another, and that it is not the dull rattling off of a chain that was forged innumerable ages ago. This appearance, which makes life and history tingle with such a tragic zest, *may* not be an illusion. As we grant to the advocate of the mechanical theory that it *may* be one, so he must grant us that it may *not*. And the result is two conceptions of possibility face to face with no facts definitely enough known to stand as arbiter between them." And he adds that one can leave the question open, or let one's general philosophy incline the beam. In his own case, for ethical reasons unstated, he sides with the believers in the cause-theory, or that consciousness is a spiritual force.

The remainder of Vol. I is Chapter XII, Conception; Chapter XIII, Discrimination and Comparison; Chapter XIV, Association; Chapter XV, The Perception of Time; Chapter XVI, Memory. They are spirited and in esting, and especially instructive to teachers.

The opening chapter of Vol. II is upon Sensations, and discusses such general questions as the Cognitive Function of Sensation and The Relativity of Knowledge, which answers the question whether our objects of knowledge contain absolute terms or consist altogether of relations. These sections occupy twelve pages of the chapter, and the remaining thirty pages are devoted to The Law of Contrast. Then follows the chapter on Imagination, which contains an especially interesting section upon the differences of individuals in the power of imagination. The work done in this field by Fechner and Galton is set forth, and Mr. James gives also the results obtained from his own psychology-students' descriptions of their power of visual imagination. The entire chapter is very readable, although less disputatious than usual. The next three chapters are upon The Perception of Things, The Perception of Space, and The Perception of Reality, the two latter being among those the beginner is advised to omit on a first reading. The chapter on Reasoning is popular and entertaining. Of course, Mr. James insists on the intellectual contrast between brute and man, and does not admit any of the instances adduced by evolutionists to prove that the essential mental process involved in reasoning is sometimes exhibited by dogs and elephants. The chapters enumerated occupy 382 pages of the volume. The next three chapters, occupying 200 pages, are upon Instinct, The Emotions, and Will. There is a short chapter on Hypnotism, in which the various theories concerning it are discussed in the usual vein. These theories are (1) Animal Magnetism; (2) Neurosis; and (3) Suggestion, the latter of which, Mr. James says, is quite triumphant at the present day over the neurosis theory, as held at the Salpêtrière.

The last chapter in the book, on Necessary Truths and the Effects of Experience, is an elaborate effort to discredit all attempts of the experience philosophy to explain the genesis of our mental structure. As Mr. Spencer is the thinker who has done most in this direction, of course it is his especial doctrines that are first of all overthrown. This is done in the usual way by means of half statements and unwarranted assumptions. To gain his point he regards the process of adaptation, which Mr. Spencer calls direct equilibration, as the way of experience proper, the front-door way; but the process which Darwin named "accidental variation," and which Mr. Spencer terms indirect equilibration, he calls the back-door way, and says: "Both these processes are of course natural and physical; but they *belong to entirely different physical spheres*." (The Italics are ours.) This is a pure assumption, the contrary of which is made more and more manifest as the observations of naturalists are extended. Yet on this assumption the meaning of experience is given as "*processes which influence the mind by the front-door way of simple habits and association*" (the Italics are the author's); and back-door processes are said to be "pure *idiosyncrasies*, spontaneous variations, fitted by good luck to take cognizance of objects without being in any intelligible sense immediate derivations from them." It is in such ways as this that Mr. James is able to be both scientist and metaphysician, evolutionist and anti-evolutionist, as the peculiarities of his own mind determine.

A Text-book of Comparative Physiology. By Wesley Mills, M. D., D. V. S. New York: D. Appleton & Co. Pp. 636. Price, $3.

Like the author's Text-book of Animal Physiology, recently published, this work is designed primarily for students and practitioners of veterinary medicine. It is intended to replace the text books of human physiology, which such students have been using, with something adapted to their special needs. The physiology of man is so different from that of most of the domestic animals, that books of the former class are very unsatisfactory for the use of veterinary students. Prof. Mills has accordingly prepared a volume somewhat smaller than his Animal Physiology, embodying the same general plan, but with greater specialization for the domestic animals. The plan of both books is thus described: "I have endeavored to set before the student a short account of what has been deemed of most importance in general biology; to furnish a full account of reproduction; to apply these two departments throughout the whole of the rest of the work; to bring before the student enough of comparative physiology in its widest sense to impress him with the importance of recognizing that all medicine, like all science, is, when at its best, comparative; and to show that the doctrines of evolution must apply to physiology and medicine as well as to morphology." Its comprehensive scope and clearness of style make it an excellent introduction to the study of comparative physiology for the use of the general student. The volume is finely printed and contains 476 illustrations. Among the pictures of especially wide usefulness are several pages of cuts showing the appearance of the teeth of horses, oxen, and other domestic animals at different ages.

An American Geological Railway Guide. By James Macfarlane, Ph. D. Second edition, revised and enlarged. Edited by James R. Macfarlane. New York: D. Appleton & Co. Pp. 426. Price, $2.50.

There are three classes of people whom this book is intended to serve: first, the general traveler who is interested in the interpretation of the various aspects of nature; second, geologists, and especially students of geology; and, third, those who wish to know where useful minerals are likely to be found. The body of the work consists of lists of the stations on the railroads of the United States, Canada, and Mexico, with the name of the geological formation at each place. The distance of each station from one terminus of the road is given, and the altitude above sea-level of most. Prefixed to these lists are descriptions of the geological formation "intended for railway travelers who are not versed in geology." A multitude of foot-notes give interesting facts in addition to the information contained in the lists. To the traveler this work offers an opportunity to learn something of geology during the usually tedious hours of railway journeys; to the geologist it will furnish aid in selecting routes for geological excursions; to the man interested in the material development of new regions it may serve as a key to the capabilities of any given locality as regards products of the soil and underground wealth. The second edition, edited by the son of the author, contains twice as much matter as the first. The editor has had the assistance of the State Geologist or of some other gentleman well acquainted with the local geology in each State. The lightness which the traveler demands in what he carries has been secured in this volume by the use of thin but tough paper and a strong, flexible cloth cover.

Economic and Social History of New England: 1620–1789. By William B. Weeden. In two volumes. Boston: Houghton, Mifflin & Co. Price, $4.50.

History, which formerly chronicled only the doings of kings and chieftains, and later developed into the life-record of the state, has now extended its scope to the affairs of the people. Its field is thus made to include a multitude of forces, individually small but mighty in the aggregate, which have always had a potent influence in shaping the courses of nations and in causing the success or the overthrow of rulers. Events otherwise inexplicable are seen to be natural sequences, when the temper of a people becomes known as revealed in their conduct of commercial, social, religious, and family affairs. Probably no region with an equal length of history is so rich in materials for a record of social life as New England. The early New-Englanders conscientiously recorded their business and public transactions, and complacently wrote out their ideas and opinions upon current topics, and later generations have proudly preserved these memorials. Hence the wealth of detail that Mr. Weeden has been able to include in his panorama. Among the important institutions of New England to which the author early calls attention are the towns. These, he states, "were founded on three leading principles: (1) Freehold land regulated by the best usage of many centuries. (2) A meeting, the local and social expression of religious life and family culture. (3) A representative democratic gathering, corresponding to the old folk-mote of the Germanic races." We find town regulations affecting all the affairs of daily life, even some of the most minute and personal. Many of them had to be repealed almost as soon as made; yet the fact that others were allowed to stand and were tolerably observed shows in the colonists a great reverence for the wisdom of the majority. The approved method for dividing the land in a town was that each grantee should have a home lot near the "place for Sabbath assembly," and a field for cultivation farther away. There were also tracts for pasturing the cattle in common herds. The holding and transfer of real estate were among the matters closely regulated. Dorchester, in 1634, enacts that "no man within the Plantation shall sell his house or lott to any man without the Plantation, whome they shall dislike off." In Nahant, colonized by Lynn in 1657, the householders are to have lots of equal size, "noe man more than another." The co-occupation of the country with the Indians had its influence on the customs of the colonists, and the trespasses which the latter committed upon their red-skinned brethren reveal some weaknesses of the Puritans' character that their religion did not save them from. Church and civil government were closely interwoven. In Massachusetts and Connecticut the franchise depended on connection with the church; on the other hand, ministers were commonly chosen in open town meeting, and marriages were performed only by magistrates. The trade in beaver-fur and that in cured fish were of much importance. Permission to keep taverns was voted as early as 1630, but inn-keepers must not force meals at 12*d.* and above on "pore people." The sale of wines and liquors was wholly prohibited in the Massachusetts Bay Colony in 1637, but the very next year licenses began to be granted. Ship-building and commerce had a rapid growth, and the colonial merchants were soon able to build "fair and stately houses." Many industries were early established; the first saw-mill was set up at Piscataqua (Portsmouth, N. H.) in 1631. Grist-mills were already in use. Nicholas Easton established a tannery at Ipswich in 1634. Goodman Fitt, a tailor, is empowered by Charlestown "to set up a salt pan, if he can live upon it, and upon his trade." In 1639 John Hull notes in his diary, "We began to print at Cambridge." Iron-works were established at Lynn in 1643, and at Braintree soon after. Among the colonial laws none seem now so quaint and preposterous as those regulating manners and morals. The "blue laws" of Connecticut are proverbial. In that colony no food or lodging could be given to a Quaker, Adamite, or other heretic. Whoever brought cards into the dominion paid a fine of five pounds. No one could read common prayer, keep Christmas or saints' days, make mince pies, dance, play cards, or play on any instrument of music except the drum, trumpet, and jew's-harp. Tobacco must not be taken "publiquely in the street, highwayes, or any barne-yards, or uppon traineing days in any open places." Massachusetts made rules no less meddlesome. Sunday observance and economical dress were strictly enforced. Class distinctions were strong, and often caused much bitterness. They ruled the seating of the people in church; thus Stamford, Conn., in 1673 votes to seat its people according to "dignity, agge, and estate in this present list of estate." At Saco, in 1669, two men were voted into the first seat, and their wives into the third. Tithing-men with long staffs, having a knob at one end and a fox-tail at the other, rapped or tickled the sleepers in meeting. The above is a sample of the material that fills Mr. Weeden's nine hundred pages. Among the other topics upon which he gives information are means of travel and communication, agriculture, forced service of Indians which was followed by negro slavery, currency of wampum, coin, and paper, privateers and pirates, whaling, the East India trade, the lives of notable men of the time—such as Hull, the Pepperells, Sewall, Amory, the Faneuils, Edwards, Franklin, and Derby—and the effects of England's regulations upon colonial life and commerce. The sources from which Mr. Weeden has drawn his material include the archives and probate records of Massachusetts, Rhode Island, and Connecticut, manuscripts and newspapers in the possession of various historical societies, the diaries of John Hull and Judge Sewall, and various town histories and other historical works. Numerous specific references to sources are given in foot-notes. Appendixes contain a list of prices of labor and commodities in different years from 1630 to 1789, examples of early accounts, reminiscences of Samuel Slater, the first cotton manufacturer in America, etc. An index of fifty pages makes all the references to any topic easily accessible.

Outlines of General Chemistry. By Wilhelm Ostwald, Professor of Chemistry in the University of Leipzig. Translated by James Walker, D. Sc. London and New York: Macmillan & Co. Pp. 396. Price, $3.50.

This is a work on chemical philosophy adapted to college students who have some acquaintance with descriptive chemistry. An especially notable feature of it is the pains taken by the author to make his subject plain, and to give the student just ideas in regard to the relative importance and trustworthiness of the results which the science has thus far attained. To this fact the large size of the volume is chiefly due. As it is not designed for those who intend to go into the higher aspects of the science, the higher mathematics has not been employed. Another feature of the work is the connected account it gives of the discoveries of van't Hoff in regard to solution and those of Arrhenius concerning electrolytic dissociation, made within the last three or four years, and not yet generally recognized by English-speaking chemists. The translating is evidently well done, but the inconvenient German style of index is retained.

The papers and discussions found in the *Circular of Information No. 2*, issued by the United States Bureau of Education in 1889, are especially valuable to those interested in the question of educational methods. In The Relation of Manual Training to Body and Mind, Prof. Woodward gives an outline of the work undertaken in the St. Louis Manual Training School. This department of Washington University has been in operation nine years, and the *verbatim* reports of parents show that the students are not only physically benefited by this system, but accomplish as much mentally and develop greater zest for acquirement than when trained merely in an intellectual direction. Dr. Harris, treating of the psychology, gives his reasons for preferring the drill in reading, geography, arithmetic, and especially grammar, to any discipline in tool-work. He insists upon the distinction between higher and lower faculties; that "we do not get at the true reality by sense perception but by thought"—"man elevates himself above the brute creation by his ability to withdraw his attention from the external world of the senses and give attention to forces, causes, principles." The province of the school, therefore, is to make the pupil master of the tools of thought, to furnish him "with means for availing himself of the mental products of the race." Superintendent Seaver gives, as a result of experience, that "such instruction takes a strong hold on the minds of a large class of boys who are either not so well reached, or not reached at all, by the subjects and methods of teaching current in the older high schools." Other suggestive papers are those on Psychology in its Relation to Pedagogy, by Dr. Butler; How can Manual Training be introduced into Ungraded Schools? by Prof. Allen; and The State and Higher Education, by Superintendent Campbell and Prof. Adams. The discussions on the training of teachers and on the value of examinations will tend to alter the gauge of any narrow-minded educator who may read them.

A *History of Education in Alabama*, prepared by Willis G. Clark, is the subject of *Circular of Information No. 3*, 1889. This is the eighth monograph in the series, and, apart from its historical and local worth, it is deserving of study as an exhibit of intellectual growth remote from well-recognized centers. The fact that Alabama has possessed a State institution of learning for seventy years, supplying from one of her professors a President for Columbia College—the late Dr. Barnard—and that Howard College, in the same State, has furnished Harvard with a Professor of Hebrew and Assyrian, shows that the East and North do not monopolize thoroughness in scholarship. It is well to learn that "the Southern city of Mobile, in 1853, could boast of a public-school system with methods as advanced . . . and discipline as effective as in the justly famed schools of New England." As early as 1867 the public-school commissioners acted in concert with the Freedman's Bureau to extend education to colored children. The report for 1888 shows an enrollment in the schools of 98,919 colored pupils, with salaries paid to colored teachers amounting to $183,933.97. Among the State institutions enumerated as *educational* is the Alabama Insane Hospital. The classification is scarcely warrantable, although the leading forth and restoration of mind rest on the same psychological basis. The institution is worthy of note on its own account. Under the care of the distinguished alienist, Dr. Boyce, 1,011 patients are managed without mechanical constraint, healthful and varied occupation having been substituted for irrational confinement and isolation. This pamphlet is fully illustrated with views of colleges, library, and laboratory interiors.

In the preface to *A Report on Medical Education, Medical Colleges, and the Regulation of the Practice of Medicine in the United States and Canada*, it is asserted that there has been greater progress in the direction of a higher medical education in the year 1889 than in the preceding five years. Various States have made obligatory a preliminary examination of those intending to pursue medical studies, and three additional States have passed acts requiring, as a condition of practice, evidence of graduation at a medical college in good standing, or, a satisfactory examination by an authorized board. Twenty-seven colleges now insist upon four years' study and three annual courses of lectures, while only four made such requirement in 1889. It is suggested that the standard will be further advanced in seven institutions by the provision of *four* annual series of lectures. The total number of colleges now in existence in the United States and Canada is given as one hundred and thirty-nine; forty-seven of these are open to both sexes. More than a hundred colleges have chairs of Hygiene and Medical Jurisprudence; lectures on bacteriology are given in six colleges and two post-graduate schools, while a large number afford laboratory practice. The information furnished by the pamphlet includes titles, locations, addresses of corresponding officers, curricula of study, fees, number of matriculates and graduates. The records of a large number of fraudulent institutions are also given. The data are arranged in alphabetical order as to States; but a full index is appended, by means of which any medical school may be readily located.

In the *Educational Value of Manual Training*, Prof. C. M. Woodward dissects the arguments contained in a report on the subject made to the Council of Education in July, 1889. To ground the reader fairly in the debate, the report itself is printed in full, also a critical review of it, by Gilbert B. Morrison. The author fears that the report, which has been published many times, may lead to wrong inferences concerning manual training. It is the fugitive side-discussions and incidental definitions to which he objects. He discusses the curriculum of the manual training school; school tool-work *vs.* trade-work; the age of pupils; relation to social evils; comparison with pure science; intellectual powers; the economic value, and the argument against liberal culture in tool-work. The gist of the matter appears to be that, while the committee considers manual training *per se*, Prof. Woodward urges that *the system* of manual training—i. e., intellectual, scientific, and manual combined—shall be the subject of investigation.

The spread of educational interest is illustrated in *A Short History of the Educational Society of Japan*, 1890. It is published by the society, and printed at the Tsukijo Kwappan Teizōsho, Tōkyo, Japan. The present association is the resultant from the union of two former societies, and it has been in existence six years. Its outlook is flourishing. It issues a journal, of which 331,559 copies have been published and has a library of 28,140 volumes, including 750 European books as well as Japanese and Chinese works. Rules for the government of the society are given, and to these is added a list of the patrons, officials, and members. His Imperial Highness Prince Arisugawa Taruhito, is honorary president of the society.

A course of *Progressive Exercises in Practical Chemistry* has been prepared by Dr. *Henry Leffmann* and Mr. *William Beam*

(Blakiston). It includes the exercises that have been given for several years in the Woman's Medical College and in the Pennsylvania College of Dental Surgery, in Philadelphia. The first fourteen pages are devoted to descriptions of apparatus and manipulations, illustrated with forty-two cuts. The rest of the book is occupied by directions for 253 experiments arranged to illustrate successively the general principles of chemistry, the properties of the important elements, and electrical decomposition. The authors state that they have "given much attention to details as to quantity of materials to be used and arrangements of apparatus. Some of the experiments and forms of apparatus are new, and have been devised especially with a view to economy." The book is "adapted for use in conjunction with any manual of elementary chemical principles, or to be supplemented by lectures."

Henry C. Northam has prepared a *Manual of Civil Government* (Bardeen), intended for public instruction in the State of Missouri. It is arranged in the form of a catechism, and takes up the history of the organization of the Government of the United States; city, village, and State government as existing in Missouri, giving the duties and salary of each officer; the organization and jurisdiction of the various courts; presidential elections; the two Houses of Congress; etc. The Declaration of Independence and the Constitution of the United States are appended. The State Constitution of Missouri is not given.

A little calisthenic manual, entitled *Home Exercise for Health and Cure*, by *D. G. R. Schreber, M. D.*, has been translated by *Charles R. Bardeen* (Bardeen). It consists of directions for forty-five exercises which require no apparatus. These are followed by combinations of the exercises, adapted to different forms of weakness and to the daily needs of persons of different ages and both sexes. General suggestions and remarks precede and follow the above matter. Where clearness requires it the exercises are illustrated. The publisher states that in Germany teachers are expected to be familiar with the book, and that 140,000 copies of it had been sold up to 1889.

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POPULAR MISCELLANY.

Philosophy at Harvard.—The courses of study in philosophy that are offered to students by Harvard University for the year 1890-'91 number seventeen. In the elementary courses, students attend one, two, or three lectures or recitations a week, as the case may be. Advanced students carry on their studies mostly by themselves, meeting for a conference with the professor once a week. The facilities for philosophical study at Harvard have about doubled within the last ten years. In 1880-'81 there were ten courses in philosophy for undergraduates and graduates, two of which were given only in alternate years, the instructors being Prof. Bowen, and Asst. Profs. Palmer and James. These dealt with logic, psychology, ethics, contemporary philosophy, earlier English, French, and German philosophy, German philosophy of the present day, and the history of philosophy. Courses covering substantially the same ground are given now, besides which four courses given in the Divinity School, on the philosophy of religion, are open to general students of philosophy, and there have been added a course on Greek philosophy and three which deal with modern thought and modern problems. One of these last is called Cosmology: a Discussion of the Principal Problems of the Philosophy of Nature, with Special Reference to the Doctrine of Evolution, and embraces lectures by the professor and the writing of theses by the students. For the current year three theses upon assigned topics will be required, and are to be based upon the private reading of Herbert Spencer's First Principles, and of Le Conte's Evolution in its Relations to Religious Thought, and other reading to be announced. Another of the newer courses deals with the ethics of the social questions—charity, divorce, the Indians, temperance, and the various phases of the labor question. The mode of study includes lectures, essays, and practical observations. There are also three "seminaries" for advanced students—a psychological, a metaphysical, and an ethical—and guidance will be furnished to students who wish to take up individual investigations of questions in ethics. In the psychological seminary the subject for the current year is Pleasure and Pain, and it will be studied by means of lectures, essays, and laboratory work. The present officers of the Philosophical Department are Profs. G. H. Palmer, A. M., C. C. Everett, D. D., William James, M. D., and F. G. Peabody, D. D., Asst. Prof. Josiah Royce, Ph. D., and George Santayana, Ph. D., instructor.

The Founder of Inebriate Asylums.—A sketch of the late Dr. J. Edward Turner, founder of the first inebriate asylum in the world, has been published by T. D. Crothers, M. D., in The Quarterly Journal of Inebriety. Dr. Turner was born in Maine, in 1822, and had his mind turned to the subject of his life work by being called upon to take care of an inebriate uncle at intervals of several months, during his student life and after he began to practice medicine. When he first mentioned his idea of an asylum, where such cases could be secluded, housed, and treated, it was received with derision and contempt. He went to Europe in 1843, and spent two years visiting hospitals and asylums, and discussing his ideas with medical men. On his return he began the systematic collection of facts concerning inebriety. About this time Drs. Valentine Mott and John W. Francis became interested in his plan for an asylum, and continued all their lives to be his warmest friends. There was much bitter opposition to the idea of treating drunkenness as a disease, and still more indifference to the matter, so that Dr. Turner made but slow headway. In 1848-'49 he made a second visit to Europe. After his return he began to solicit subscriptions to the stock of a company to build an inebriate asylum. A charter was obtained from the State of New York, and finally, in 1858, ground was broken at Binghamton for a building planned by Dr. Turner, and the erection of which he personally superintended. By persistent petitioning he obtained from the New York Legislature a grant of one tenth of the money obtained each year from liquor licenses, for the building and maintenance of the asylum. In 1862 Dr. Turner married. The building had progressed far enough in 1864 to open it for patients, and a number of inebriates were admitted. At this point success seemed to have crowned the efforts of the founder. He had won over public opinion to his side, and the most active interest was being manifested all over the State in the work. But trouble arose over the mode of treatment. Dr. Turner's system was military in its strictness, his first principle being, that the asylum officers should have full control of the patient, and that this control should extend over a long time, and not be governed by the will of the patient or his non-expert friends. An unscrupulous, money-getting lawyer in the board of directors, and a weak president of the board, caused a division, which was followed by persecution of Dr. Turner, and his resignation as superintendent in 1867. The asylum was then sold to the State for a nominal consideration, and thirteen years later was changed to an insane hospital, being known now as the New York State Insane Asylum at Binghamton. The transfer was not legally made, and Dr. Turner began a suit for possession of the property, which was never carried to an issue. Dr. Turner then undertook to raise subscriptions for a woman's hospital for inebriates and opium-eaters. After three years, the subscriptions in money and materials had reached a great amount, ground had been broken for a building, when the Legislature of Connecticut crushed the scheme by repealing the charter previously granted. For the next two years after this discouraging defeat Dr. Turner occupied himself with writing a book called the History of the First Inebriate Asylum in the World, which was a general account of his forty years' efforts. He then started out to sell the work, and to solicit aid to push his suit for the Binghamton asylum, and was busied thus when he died, July 24, 1889. Dr. Turner's career was a striking example of overwhelming defeat for the individual joined with signal triumph for his idea. Inebriety is being more widely recognized as a disease each year. There are to-day over one hundred inebriate asylums in the world, all the direct result of his efforts in founding the first one at Binghamton.

Origin of American Public Museums.—The first chapter in the history of American museums, says Dr. G. Brown Goode, in his lecture on museums, is short. In the early years of the republic, the establishment of such institutions by city, State, or Federal Government would not have been considered a legitimate act. When the General Government came into the possession of extensive collections as the result of the Wilkes Exploring Expedition in 1842, they were placed in charge of a private organization, the National Institution, and later, together with other similar materials, in that of a corporation, the Smithsonian Institution, which was for a long period of years obliged to pay largely for their care out of its income from a private endowment. It was not until 1876 that the existence of a National Museum, as such, was definitely recognized in the proceedings of Congresss, and its financial support fully provided for. In early days our principal cities had each a public museum, founded and supported by private enterprise. The earliest general collection was that formed at Norwalk, Conn., prior to the Revolution, by a man named Arnold, described as "a curious collector of American birds and insects." This it was which first awakened the interest of President John Adams in the natural sciences. He visited it several times, as he traveled from Boston to Philadelphia, and his interest culminated in the foundation of the American Academy of Arts and Sciences. In 1790 Dr. Hosack brought to America from Europe the first cabinet of minerals ever seen on this continent. The earliest public establishment was the Philadelphia Museum, founded by Charles Wilson Peale in 1785, which had for a nucleus a stuffed paddle-fish and the bones of a mammoth, and was for a time housed in the building of the American Philosophical Society. In 1800 it was full of popular attractions. The Baltimore Museum was managed by Rembrandt Peale, and was in existence as early as 1815 and as late as 1830. Earlier efforts were made, however, in Philadelphia. Dr. Chovet, of that city, had a collection of wax anatomical models made by him in Europe; and Prof. John Morgan, of the University of Pennsylvania, who learned his method from the Hunters, in London, and Sué, in Paris, had begun to form such a collection before the Revolution. The Columbian Museum and Turell's Museum, in Boston, are spoken of in the annals of the day; and there was a small collection in the attic of the State House in Hartford. The Western Museum, in Cincinnati, was founded about 1815, by Robert Best, M. D., afterward of Lexington, Ky., who seems to have been a capable collector, and who contributed matter to Goodman's American Natural History. In 1818 a society styled the Western Museum Society was formed among the citizens, which, though hardly a scientific organization, seems to have taken a somewhat liberal and public-spirited view of what a museum should be. With the establishment of the Academy of Natural Sciences in Philadelphia in 1812, and the New York Lyceum of Natural History, the history of American scientific museums had its true beginning.

The Question of Tertiary Man.—The antiquity of man and an account of anthropological museums were the chief topics discussed in the address of Mr. John Evans, President of the Anthropological Section of the British Association. The question of the antiquity of man, the author said, is susceptible of being separated from any speculations as to the generic descent of mankind; and even were it satisfactorily answered to-day, new facts might to-morrow come to light that would again throw the question open. On any view of probabilities, it is unlikely that we shall ever discover the exact cradle of our race, or be able to point to any object as the first product of the industry and intelligence of man. We may, however, the author thought, hope that from time to time fresh discoveries may be made of objects of human art, under such circumstances and conditions that we may infer with certainty that at some given point in the world's history mankind existed, and in sufficient numbers, for the relics that attest this existence to show a correspondence among themselves, even when discovered at remote distances from each other. After reviewing the course of discovery of prehistoric man, and the considerations on which the attempt is based to show that he existed in the Tertiary, Mr. Evans declared his conclusion that on the whole the present verdict as to Tertiary man must be in the form of "not proven." When we consider the vast amount of time comprised in the Tertiary period, with its three great principal subdivisions of the Eocene, Miocene, and Pliocene, and when we bear in mind that of the vertebrate land animals of the Eocene no one has survived to the present time, while of the Pliocene but one—the hippopotamus—remains unmodified, the chances that man, as at present conditioned, should also be a survivor from that period seem remote, and against the species *Homo sapiens* having existed in Miocene times almost incalculable. The *a priori* improbability of finding man unchanged, while all the other vertebrate animals around him have, from natural causes, undergone more or less extensive modification, will induce all careful investigators to look closely at any evidence that would carry him back beyond Quaternary times; and though it would be unsafe to deny the possibility of such an early origin for the human race, it would be unwise to regard it as established except on the clearest evidence.

Embryological Recapitulation.—Prof. A. Milnes Marshall, in his presidential address before the Biological Section of the British Association, after remarking on the general subject of the study of embryology, spoke more particularly of its relation to the doctrine of recapitulation, which, suggested by Agassiz, had been elaborated by eminent contemporary zoölogists. Natural selection, he showed, explains the preservation of useful variations, but does not account for the formation and preservation of useless organs; but recapitulation solves the problem at once, by showing that those organs, though now useless, must have been of functional value to the ancestors of their present possessors, and that their appearance in the ontogeny of existing forms is due to the repetition of ancestral characters. Such rudimentary organs are, as Darwin has pointed out, of larger relative or even absolute size in the embryo than in the adult, because the embryo represents the stage in the pedigree in which they were functionally active. Rudimentary organs are extremely common, especially among the higher groups of animals, and their presence and significance are now well understood. Man himself affords numerous and excellent examples, not merely in his bodily structure, but by his speech, dress, and customs. For the silent letter *b* in the word doubt, or the *w* of answer, or the buttons on his elastic-side boots are as true examples of rudiments unintelligible but for their past history, as are the ear muscles he possesses but can not use, or the gill-clefts which are functional in fishes and tadpoles, and are present, though useless, in the embryos of all higher vertebrates. It was the elder Agassiz who first directed attention to the remarkable agreement between the embryonic growth of animals and their palæontological history.

The Scope of Mathematics.—Mr. J. W. L. Glaisher, President of the Mathematical Section in the British Association, in his address spoke of the range of subjects comprehended within the scope of mathematics. Its field extends from the most exact of all knowledge to branches of inquiry in which only uncorrelated facts have been collected. Considering pure mathematics, or that of the abstract sciences which could be conquered and explored only by mathematical methods, it is difficult not to feel somewhat appalled by the enormous developments it has received in the last fifty years. The mass of the investigations, as measured by the annual additions to the literature of the subject, is so great that it is fast becoming bewildering from its mere magnitude and the extraordinary extent to which many special lines of study have been carried. There can be no end to this. So wide and various are the subjects of research, so interesting and fascinating are the results, so wonderful are the fields of investigation laid open at each succeeding advance, that we may be sure that, while the love of learning and knowledge continue to exist, there can be no relaxation of our efforts to penetrate still further into the mysterious worlds of abstract truth that lie spread temptingly before the investigator. The speaker did not believe that the bearing of the modern developments of mathematics on the physical sciences is likely to be very direct or immediate, but it would be rash to assert that there is any branch of mathematics so abstract or so recondite that it may not at any moment find an application in some concrete subject. Still, it appears that if the extension of the pure sciences can only be justified by the value of their applications, it is very doubtful whether a satisfactory plea for any further developments can be sustained. Although the condition of mathematical science in England is not fully satisfactory, there is more cause for congratulation at present than there has been at any time during the last one hundred and fifty years, and we are far removed from the state of affairs that existed before the days of Cayley and Sylvester. The author concluded with a plea for the study of the theory of numbers.

Value of Living Traditions.—According to Mr. J. G. Frazer, the author of a comparative study of religions, entitled the Golden Bough, the best source for knowledge of ancient folk-lore is among the people of the present. Every inquiry into the primitive religion of the Aryans, he says, "should either start from the superstitious beliefs and observances of the peasantry, or should at least be constantly checked and controlled by reference to them. Compared with the evidence afforded by living tradition, the testimony of ancient books on the subject of early religion is worth very little. . . . The mass of the people who do not read books remain unaffected by the mental revolution wrought by literature; and so it has come about that in Europe, at the present day, the superstitious beliefs and practices which have been handed down by word of mouth are generally of a far more archaic type than the religion depicted in the most ancient literature of the Aryan race."

The Magnetograph.—The magnetograph, the adaptability of which to use as a seismoscope has been tried by Prof. T. C. Mendenhall, is described by him as a system of magnetic needles, free to vibrate, and connected with a mirror that turns with the needles. It has long been noticed that an earthquake causes a considerable disturbance of the needles; and that this is not an effect of vibration is shown by the fact that a series of brass needles is not thus disturbed. It appears from the study of the magnetic records that there are two distinct vibrations, one due to solar influence and seeming to be dependent jointly on position and temperature; the other series were dependent on the relative position of the earth and the moon, and were therefore regarded as of a tidal nature; and the disturbances of the magnetic needle may be, and probably are, due to the stress of the earth's crust. The author mentioned as a remarkable fact that a periodic disturbance, smaller in amplitude than the thickness of the line recorded, could be positively and perfectly determined. This evidence that the lunar influence is due to variation of stress furnishes a clew to the explanation of the disturbances due to earthquakes. The stress to which the earth is then subjected causes an alteration in its magnetic condition which is recorded upon the sheet. It may therefore be possible to recognize an earthquake by disturbance of the magnetic needle, even when the motion is too small to be recognized by a seismoscope. It is a curious fact that it is supposed in Japan that an earthquake can be predicted by the vibrations of a loadstone.

The Natural Gas Supply.—The permanence of the natural gas supply was discussed in the American Association, which, meeting in the heart of the natural gas region, visited some of the more famous stations at Noblesville, Marion, Muncie, and Anderson, where the new fuel is used. President Goodale warned the people at Anderson against waste of the gas, because, he said, it will surely give out some day. Dr. Edward Orton affirmed in a paper in the Economic Section that the supply in the Indiana and Ohio fields is not only exhaustible, but is rapidly and surely being exhausted. It is not now being generated, and every foot that escapes to the surface leaves the quantity remaining for future use just so much smaller. This is proved by the fact that the pressure of the gas is steadily diminishing, the decrease having already amounted to thirty or forty per cent. Prof. P. H. Vander Weyde is of a different opinion. He believes that the gas is formed in much the same manner as water-gas; that the evolution of oxygen and hydrogen is constantly going on in the regions of the earth's interior, where the temperature of dissociation exists; and that when carbureted metals having great affinity for water are present within reach of the dissociated gases, they will be oxidized by the ascending oxygen, while the hydrogen will combine with the carbon to form hydrocarbons. Thus the process of generating the gas is going on all the time, and the prospect for the continuation of the supply is cheerful. "Look," the author says, "at the burning gas-wells of Baku, where the gas escapes by fissures in the soil, and has been blowing and burning for centuries, and all for nothing thus far. There appears to be no diminution in their flow, while from the Chinese historical records it appears that natural gas has been evolving in more than one locality for at least a thousand years, and I expect the same here. It comes from regions far below the deepest coal mines, and may continue to flow when some mines are exhausted."

Geography-teaching in Russia.—The object of a paper in the British Association, by Dr. H. R. Mill, on Geographical Teaching in Russia, was to give an idea of the method of instruction as prescribed by the official syllabus enforced in government and private schools. The books are generally illustrated by black and white maps, and by diagrams of great interest and ingenuity, exemplifying statistics in graphic form. It is characteristic of the Russian system to go deeply into statistics. The absence of pictures in the instruction books is noticeable, but subjects are treated exhaustively. Greater attention is paid to ethnography than in the system of any other country, because, probably, of the many races among which the subjects of the Czar are divided. Russians are in the habit of regarding Asia rather than Europe as nearest to them.

Coffee-drinking.—Dr. Mendel, of Berlin, has recently published a clinical study on Coffee Inebriety. His observations were made upon the women of the working population of Essen, a town in Prussia, Department of Dusseldorf. He found large numbers of women who used over a pound of coffee a week. The leading symptoms are profound depression, frequent headache, and insomnia. A strong dose of coffee relieves this for a time; a partial loss of power over the muscles occurs, and an increasing aversion to labor. The heart's action becomes rapid and irregular. Dyspepsia of an extreme nervous type is present. Brandy offers only a temporary relief. The face becomes sallow and the hands and feet cold. Acute inflammation is likely to occur; an injury to any part of the body is the starting point for inflammation of an erysipelatous character. Melancholy and hysteria are common symptoms. Many opium and alcoholic cases have an early history of excessive use of coffee.

The Dangers of the Present Mode of Burial.—Human effluvium from the living body, taken into the lungs or stomach, is a well-recognized cause of disease. That it is not, at the least, equally so from the body dead, especially when it is putrescent, is difficult to believe. The following, taken from Johnson on Tropical Climates (American edition, p. 83), is an illustrative case: "An American merchant-ship was lying at anchor in Whampoa Roads, sixteen miles from Canton. One of the crew died from dysentery. He was taken on shore to be buried. No disease of any kind had occurred in the ship during her voyage from America to the river Tigris. Four men accompanied the corpse, and two men began to dig the grave. Unfortunately, they pitched upon a spot where a human body had been buried two or three months previously (as was afterward ascertained). The instant the spade went through the lid of the coffin a most dreadful effluvium issued forth, and the two men fell down nearly lifeless. It was with the greatest difficulty that their companions could approach near enough to drag them from the spot and fill up the place with earth. The two men now recovered a little, and with assistance reached the boat and returned on board." Both died—one on the evening of the fourth and the other the morning of the fifth day—of a malignant fever, with symptoms resembling plague. The other two men, who were less exposed, were similarly affected, but recovered. That the poisonous emanations inhaled in this case would have been any less dangerous if swallowed with the subsoil water in the vicinity can be surmised by those only who believe inhumation of the dead to be without danger to the living.

An Early Form of Telegraphy.—Among the early devices for conveying information to a distance by means of signals the following is very ingenious. It was used by a Grecian general, Æneas, who flourished in the time of Aristotle. It consisted of two exactly similar earthen vessels filled with water, each provided with a cock that would discharge an equal quantity of water in a given time, so that the whole or any part of the contents would escape in precisely the same period from both vessels. On the surface of each floated a piece of cork supporting an upright, marked off into divisions, each division having a certain sentence inscribed upon it. One of the vessels was placed at each station, and when either party desired to communicate with the other he lighted a torch which he held aloft until the other did the same, as a sign that he was all attention. On the sender of the message lowering or extinguishing the torch, each party immediately opened the cock of his vessel, and so left it until the sender relighted his torch, when it was at once closed. The receiver then read the sentence on the division of the upright that was level with the mouth of the vessel, and which, if everything had been executed with exactness, corresponded with that of the sender, and so conveyed the desired message.

NOTES.

Mr. John T. Campbell presented, in the American Association, the evidence in support of his belief that there was, in the Wabash River, one last great flood near the close of glacial time, and that then the water-supply was so cut off or diminished that there was never another freshet large enough to wipe out or modify the marks it left. This flood, in the opinion of the author, carried about one hundred times as much water as do the great floods of the present time.

The largest barometer yet made has been put in working order in the Saint Jacques Tower, in Paris. It is forty-one feet five inches high.

The International Medical Congress met in Berlin, August 4th. Members of the medical profession were present representing every state and city in Europe, and many from North and South America. An opening address of welcome was made by the president, Prof. Virchow. Welcoming addresses were also given for Prussia and Berlin. Dr. Lassar, Secretary-General of the Congress, sketched the general plan of the labors of the Congress, and gave some statistics concerning the representation of the countries taking part in it. Dr. Hamilton, Surgeon-General of the United States Army, was the first regular speaker, and was followed by Sir James Paget and Sir Joseph Lister.

The corrosion of steel by salt water is said to be much greater than that of iron. Mr. David Phillips stated, in a recent address before the British Institute of Marine Engineers, that he had experimented from 1881 to 1888 with two plates of Bessemer boiler steel, two of Yorkshire, and two of B. B. Staffordshire boiler iron. The plates were as nearly as possible six by six by three eighths inches, and were kept immersed in salt water. The results show a great difference between the behavior of steel and iron. The steels lost 120 per cent more than the irons the first three years, when the plates were in contact; 124 per cent more the second three years, when they were insulated; and 126 per cent more for the whole period of seven years.

Unless some of our investigators of bacteria are mistaken, there seems to be hardly a situation where these minute organisms may not be found. Thus Dr. Charles M. Cresson claims to have discovered typhoid bacilli in the juice squeezed from some celery grown near Philadelphia; and the Johns Hopkins Hospital Bulletin for May, 1890, records some observations, by A. C. Abbott, upon bacteria found in the interior of large hailstones which fell during the storm of April 26, 1890.

The Australasian Association for the Advancement of Science will hold its third annual meeting at Christchurch, New Zealand, beginning January 15, 1891. Sir James Hector, F. R. S., will succeed Baron F. von Müller, F. R. S., as president, and will deliver an address. Arrangements are making to secure reduced excursion fares from the other Australian colonies, and probably from Great Britain.

In his lecture on caves, at the meeting of the American Association, the Rev. Dr. Hovey exhibited a photograph made by L. Farini, of Bridgeport, Conn., from an ordinary negative, by means of the light of the fire-fly (*Elator phocans*).

The object of certain experiments described by Mr. W. Sharp, in the British Association, was to answer the question, What is the action of the substances called drugs upon the living body of man? The conclusions arrived at were the results of experiments made upon men in sound health, with different quantities of the same drugs. In the case of fourteen drugs that were used it was found that the smallest doses administered have power to act upon the living human body; that the commonly received opinion that the actions of drugs are simply increased in degree, and not altered in character, by increasing the dose, is an error; and that the actions of drugs are sufficiently distinct to admit of classification.

An interesting account was given by the Rev. E. Jones, in the British Association, of his exploration of the Elbolten Cave, in Craven. The first chamber, the one examined, is between thirty and forty feet long, and from seven to thirteen feet wide. Relics, including remains of about a dozen men, were found in two strata. Among the objects discovered most worthy of notice were remains of a hearth, neolithic pottery, variously ornamented and coated with charcoal on the inside; pot-boilers made of rounded grit with marks of fire; pieces of silurian slates that may have been used for the sharpening of bone implements; and pieces of bone, one of which was undoubtedly used to ornament pottery.

A committee has been formed to place a marble bust of Richard Jeffries in Salisbury Cathedral. It is to cost $750, toward which subscriptions are invited.

M. Marey has succeeded in photographing the movements of an animal under water, taking proofs at the rate of fifty in a second, with exposures of from $\frac{1}{2000}$ to $\frac{1}{3000}$ of a second. A set of twelve photographs gives all the phases of the undulations which the medusa impresses upon its umbrella of a locomotor apparatus. Another series exhibits a squid leaping out of the water. A ray has been taken in profile while waving the edges of its flat body; and the curious mode of progression of a comatula has been taken.

A law was announced several years ago by M. V. Neyreneuf relative to the flow of sound through thin cylindrical pipes, which proved identical with the law declared by Poiseuille for the flow of liquids through capilliary tubes. In a later memoir the former author has sought to determine the sounds to be used and the precautions to be taken for giving their flow a well-defined character. He also describes experiments with pipes of varying lengths and diameters, and experiments upon the effect of the kind and substance of the pipe.

Mr. St. George Mivart has been appointed Professor of the Philosophy of Natural History in the University of Louvain, Belgium.

Prof. Marsh gave an account to the British Association of the gigantic *Ceratopsidæ*, or horned dinosaurs, which he had identified in the Laramie beds, near the Rocky Mountains. The Association gave him a vote of thanks for his instructive communication.

Dr. Frithiof Nansen, the Norwegian explorer whose achievement in crossing Greenland from the eastern to the western shore resulted in considerable additions to knowledge, is preparing to start in the spring of 1892 on an expedition the main object of which will be to reach the north pole.

It is shown by Prof. A. Milnes Marshall that there is great variability in nearly allied animals, and even in individuals of the same species. In proof, he refers to the difference between the French edible frog and the British frog, and says that the question as to which of these was the primitive form is a subject for interesting study.

OBITUARY NOTES.

Miss Marianne North, a distinguished English botanist, traveler, and artist, died August 30th. Her career may be said to have begun in 1869, when she started to travel with a view of illustrating the flora of some countries not then perfectly known. She visited on different excursions Teneriffe, Brazil, the West Indies, California, India, Ceylon, Borneo, Java, Japan, Australia, and the Seychelles, and brought back at various times during twelve years collections of drawings in oils and water-colors of the scenery, vegetation, and flora which she had studied in their several habitats. In 1881 she presented a series of 627 pictures to the nation, for which she erected a gallery in Kew Gardens at her own expense.

Thomas Carnelley, Professor of Chemistry in the University of Aberdeen, died August 27th, at the age of thirty-eight years. He was born in Manchester, England; had a brilliant career in Owens College; received the Dalton Chemical scholarship in 1872 for his original investigation of the vanadates of thallium; and gained it for another year, on examination; was private assistant to Prof. Roscoe, and, having studied abroad, became professor in succession at Owens College, the North Staffordshire School of Science, Firth College, Sheffield, University College, Dundee, and the University of Aberdeen. He prosecuted valuable researches in the extension and application of Mendeleef's periodic law; made chemical and bacteriological examinations of the air of dwellings, schools, etc., in Dundee and its district, which aroused interest in ventilation; and besides many contributions to English and foreign chemical journals, published a large book on certain physical constants of chemical compounds.

Signor Orazio Silvestri, a distinguished chemist and vulcanologist, recently died at Catania, Sicily, at the age of fifty-five years. He was an industrious student of the eruptions of Mount Etna, and founded the laboratory on top of the mountain at the height of upward of 13,000 feet.

Prof. Carl Frederik Fearnley, of the University of Christiania, an eminent Norwegian astronomer, died August 23d, in his seventy-third year. He was the author of numerous astronomical and meteorological publications, and had been Professor of Astronomy at the university since 1857.

ELISHA MITCHELL.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XI. FROM BABEL TO COMPARATIVE PHILOLOGY.

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PART I.

AMONG the sciences which have served as entering wedges into the heavy mass of ecclesiastical orthodoxy, to cleave it, disintegrate it, and let the light of Christianity into it, none perhaps has done a more striking work than Comparative Philology. In one very important respect the history of this science differs from that of any other; for it is the only one whose results theologians have at last fully adopted as the result of their own studies. This adoption teaches a great lesson, since, while it has destroyed theological views cherished during many centuries, and obliged the Church to accept conclusions directly contrary to the plain letter of our sacred books, the result is clearly seen to have helped Christianity rather than to have hurt it. It has certainly done much to clear our religious foundations of the dogmatic rust which was eating into their structure.

How this result was reached, and why the Church has so fully accepted it, I shall endeavor to show in the present chapter.

In the very beginnings of recorded history we find explanations of the diversity of tongues, and naturally such explanations resort to supernatural intervention. The "law of wills and causes," formulated by Comte, is exemplified here as in so many other cases. That law is, that when men do not know the natural causes of things, they simply attribute them to wills like their own; thus they obtain a theory which provisionally takes the place of science, and this theory is very generally theological.

Examples of this recur to any thinking reader of history.

Before the simpler laws of astronomy were known, the sun was supposed to be trundled out into the heavens every day and the stars hung up in the firmament every night by the right hand of the Almighty. Before the laws of comets were known, they were thought to be missiles hurled by an angry God at a wicked world. Before the real cause of lightning was known, it was supposed to be the work of a good God in his wrath, or of evil spirits in their malice. Before the laws of meteorology were known, it was thought that rains were caused by the Almighty or his angels opening "the windows of heaven" to let down upon the earth "the waters that be above the firmament." Before the laws governing physical health were known, diseases were supposed to result from the direct interposition of the Almighty or of Satan. Before the laws governing mental health were known, insanity was generally thought to be diabolic possession.*

So, in this case, to account for the diversity of tongues, the direct intervention of the Divine Will was brought in. As this diversity was felt to be an inconvenience, it was attributed to the will of a Divine Being in anger. To explain this anger, it was held that it must have been provoked by human sin.

Out of this conception explanatory myths and legends grew as thickly and naturally as elms along water-courses; and of these the earliest form known to us is found in the Chaldean accounts. We see it first in the Chaldean legend of the Tower of Babel.

The inscriptions recently found among the ruins of Assyria have thrown a bright light into this and other scriptural myths and legends; the deciphering of the characters in these inscriptions by Grotefend, and the reading of the texts by George Smith, Oppert, Sayce, and others, have given us these traditions more nearly in their original form than they appear in our own Scriptures.

The Hebrew story of Babel, like so many other legends in the sacred books of the world, combined various elements. By a play upon words, such as the history of myths and legends frequently shows us, it wrought into one fabric the earlier explanations of the diversities of human speech and of the great ruined tower at Babylon. The name Babel (*bab-il*) means "Gate of God" or "Gate of the Gods." All modern scholars of note agree that this was the real significance of the name; but the Hebrew verb which signifies *to confound* resembles somewhat the word Babel, so that out of this resemblance, by one of the most common processes in the history of myth formations, came to the Hebrew

* Any one who wishes to realize the mediæval view of the direct personal attention of the Almighty to the universe, can perhaps do so most easily by looking over the engravings in the well-known Nuremberg Chronicle, representing him in the work of each of the six days, and resting afterward.

mind an indisputable proof that the tower was connected with the sudden confusion of tongues; and this became part of our theological heritage.

In our sacred books the account runs as follows:

"And the whole earth was of one language and of one speech.

"And it came to pass, as they journeyed from the east, that they found a plain in the land of Shinar; and they dwelt there.

"And they said one to another, Go to, let us make brick, and burn them thoroughly. And they had brick for stone, and slime had they for mortar.

"And they said, Go to, let us build us a city and a tower whose top may reach unto heaven; and let us make us a name, lest we be scattered abroad upon the face of the whole earth.

"And the Lord came down to see the city and the tower which the children of men builded.

"And the Lord said, Behold, the people is one, and they have all one language; and this they begin to do: and now nothing will be restrained from them which they have imagined to do.

"Go to, let us go down, and there confound their language, that they may not understand one another's speech.

"So the Lord scattered them abroad from thence upon the face of all the earth: and they left off to build the city.

"Therefore is the name of it called Babel; because the Lord did there confound the language of all the earth: and from thence did the Lord scatter them abroad upon the face of all the earth." (Genesis, xi, 1–9.)

Thus far the legend had been but slightly changed from the earlier Chaldean form in which it has since been found in the Assyrian inscriptions. Its character is very simple; to use the words of the most eminent English-speaking authority, Prof. Sayce, of Oxford, a clergyman of the Church of England, "It takes us back to the age when the gods were believed to dwell in the visible sky, and when man, therefore, did his best to rear his altars as near them as possible." And the eminent professor might have added that it takes us back also to a time when it was thought that Jehovah, in order to see the tower fully, was obliged to come down from his seat above the firmament. In its earlier Chaldean form the legend runs, that the gods, assisted by the winds, overthrew the work of the contrivers and introduced a diversity of tongues.

As to the real cause of the building of the tower there seems a substantial agreement among leading scholars that it was erected primarily as part of a temple, but largely for the purpose of astronomical observations, to which the Chaldeans were so devoted, and to which their country, with its level surface and clear atmosphere, was so well adapted. As to the real cause of its destruction, one of the inscribed cylinders discovered in recent times, speaking of a tower which most of the leading archæologists identify with the Tower of Babel, reads as follows:

"The building named the Stages of the Seven Spheres, which was the Tower of Borsippa, had been built by a former king. He had completed forty-two cubits, but he did not finish its head. During the lapse of time, it had become ruined; they had not taken care of the exit of the waters, so that rain and wet had penetrated into the brick-work; the casing of burned brick had swollen out, and the terraces of crude brick are scattered in heaps."

We can well understand how easily "the gods, assisted by the winds," as stated in the Chaldean legend, could overthrow a tower thus built.

It may be instructive to compare with the explanatory myth developed first by the Chaldeans, and in a slightly different form by the Hebrews, various other legends to explain the same diversity of tongues. The Hindoo legend of the confusion of tongues is as follows:

"There grew in the center of the earth the wonderful 'world tree' or 'knowledge tree.' It was so tall that it reached almost to heaven. It said in its heart: 'I shall hold my head in heaven and spread my branches over all the earth, and gather all men together under my shadow, and protect them, and prevent them from separating. But Brahma, to punish the pride of the tree cut off its branches and cast them down on the earth, when they sprang up as wata trees, and made differences of belief and speech and customs to prevail on the earth, to disperse men upon its surface."

Still more striking is a Mexican legend: according to this, Xelhua, one of the seven giants rescued from the flood, built the great Pyramid of Cholula, in order to reach heaven, until the gods, angry at his audacity, threw fire upon the building and broke it down, whereupon every separate family received a language of its own.

Such explanatory myths grew or spread widely over the earth. A well-known form of the legend, more like that of the Chaldeans than the Hebrew later form, appeared among the Greeks. According to this, the Aloidæ piled Mount Ossa upon Olympus and Pelion upon Ossa, in their efforts to reach heaven and dethrone Jupiter.

Still another form of it entered the thoughts of Plato. He held that in the golden age men and beasts all spoke the same language, but that Zeus confounded their speech because men were proud and demanded eternal youth and immortality.*

* For the identification of the Tower of Babel with the "Birs Nimrud" amid the ruins of the city of Borsippa, see Sir Henry Rawlinson, and especially George Smith, Assyrian

But naturally the version of the legend which most affected Christendom was that modification of the Chaldean form developed among the Jews and embodied in their sacred books. To a thinking man in these days it is very instructive. The coming down of the Almighty from heaven to see the tower and put an end to it by dispersing its builders, points to the time when his dwelling was supposed to be just above the firmament or solid vault above the earth; the time when he exercised his beneficent activity in such acts as opening "the windows of heaven" to give down rain upon the earth; in bringing out the sun every day and hanging up the stars every night to give light to the earth; in hurling comets, to give warning; in placing his bow in the cloud, to give hope; in coming down in the cool of the evening to walk in the garden of Eden and to talk with the man he had made; in meeting one chosen man upon a mountain to give him laws, and another in the desert to wrestle with him.

But closely connected in its effects with this Babel legend was that of the naming of the animals by Adam. It was written in one of our two accounts of the creation that Jehovah came down and brought all the animals before Adam, who gave them their names. This and other indications of language, together with the Chaldean legend, which, in passing through the Jewish mind, became monotheistic, supplied to Christian theology the germs of a sacred science of philology. These germs developed rapidly in the warm atmosphere of devotion and ignorance of natural law which pervaded the early Christian Church; and so there grew a great

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Discoveries, p. 59. For a different view, see Lenormant, Histoire Ancienne de l'Orient, vol. i, p. 118. For some of these inscriptions discovered and read by George Smith, see his Chaldean Account of Genesis, New York, 1876, pp. 160–162. For the statement regarding the origin of the word Babel, see Ersch and Grüber, article Babel; also, the Rev. Prof. A. H. Sayce, in the latest edition of the Encyclopædia Britannica; also Colenso, Pentateuch examined, vol. iv, p. 268; also John Fiske, Myths and Myth-makers, p. 72; also Lenormant, Histoire Ancienne de l'Orient, Paris, 1881, vol. i, pp. 115 *et seq.* As to the character and purpose of the great tower of the Temple of Belus, see Smith's Bible Dictionary, article Babel, quoting Diodorus; also Rawlinson, especially in Journal of the Asiatic Society for 1861; also Sayce, Religion of the Ancient Babylonians (Hibbert Lectures for 1887), London, 1877, chap. ii and elsewhere, especially pp. 96, 397, 407; also Max Duncker, History of Antiquity, Abbott's translation, vol. ii, chaps. ii and iii. For similar legends in other parts of the world, see Delitch; also Humboldt, American Researches; also Brinton, Myths of the New World; also Colenso, as above. The Tower of Cholula is well known, having been described by Humboldt and Lord Kingsborough. For superb engravings showing the view of Babel as developed by the theological imagination, see Kircher, Turris Babel, Amsterdam, 1679. For the Law of Wills and Causes, with deductions from it well stated, see Beattie Crozier, Civilization and Progress, London, 1888, pp. 112, 178, 179, 273. For Plato, see the Polit., 272, ed. Steph., and elsewhere cited in Ersch and Grüber, article Babylon. For a good general statement, see Bible Myths, New York, 1883, chap. iii. For Aristotle's strange want of interest in any classification of the varieties of human speech, see Max Müller, Lectures on the Science of Language, London, 1864, series i, chap. iv, pp. 123–125.

orthodox theory of language, strong and apparently firm, which has lasted throughout Christendom for nearly two thousand years.

There had, indeed, come into human thought at the very earliest period some suggestions of the modern scientific view of philology. Lucretius had proposed a theory, inadequate indeed, but still pointing very directly toward the truth, as follows: "Nature impelled man to try the various sounds of the tongue, and so struck out the names of things, much in the same way as the inability to speak is seen in its turn to drive children to the use of gestures." But, among the early fathers of the Church, the only one who seems to have caught an echo of this truth was St. Gregory of Nyssa; as a rule, all the other great founders of Christian theology, as far as they expressed themselves on the subject, took the view that the original language spoken by the Almighty and given by him to men was Hebrew, and that from this all other languages were derived at the destruction of the Tower of Babel. This doctrine was especially upheld by Origen, St. Jerome, and St. Augustine. Origen taught that "the language given at the first through Adam, the Hebrew, remained among that portion of mankind which was assigned not to any angel, but continued the portion of God himself." St. Augustine declared that, when the other races were divided by their own peculiar languages, Heber's family preserved that language which is not unreasonably believed to have been the common language of the race, and that on this account it was henceforth called Hebrew. St. Jerome wrote, "The whole of antiquity affirms that Hebrew, in which the Old Testament is written, was the beginning of all human speech."

Amid such great authorities as these even Gregory of Nyssa struggled in vain. He seems to have taken the matter very earnestly, and to have used not only argument but ridicule. He insists that God does not speak Hebrew, and that the tongue used by Moses was not even a pure dialect of one of the languages resulting from "the confusion." He makes man the inventor of speech, and resorts to raillery: speaking against his opponent Eunomius, he says that "passing in silence his base and abject garrulity," he will "note a few things which are thrown into the midst of his useless or wordy discourse, where he represents God teaching words and names to our first parents, sitting before them like some pedagogue or grammar master." But, naturally, the great authority of Origen, Jerome, and Augustine prevailed; the view suggested by Lucretius, and again by St. Gregory of Nyssa, died out, and "always, everywhere, and by all" in the Church the doctrine was received that the language spoken by the Almighty was Hebrew; that it was taught by him to Adam, and that all other languages on the face of the earth originated from it at the dispersion attending the destruction of the Tower of Babel.*

This idea threw out roots and branches in every direction, and so developed ever into new and strong forms. As all scholars now know, the vowel points in the Hebrew language were not adopted until at some period between the second and tenth centuries; but in the early Church they soon came to be considered as part of the great miracle—as the work of the right hand of the Almighty; and never until the eighteenth century was there any doubt allowed about the divine origin of these rabbinical additions to the text. To hesitate in believing that these points were dotted by the very hand of God himself came to be considered a fearful heresy.

The series of battles between Theology and Science in the field of comparative philology opened just on this little point, apparently so insignificant—the direct divine inspiration of the rabbinical punctuation. The first to impugn the divine origin of these vocal points and accents appears to have been a Spanish monk, Raymundus Martinus, in his Pugio Fidei, or Poniard of the Faith, which he put forth in the thirteenth century. But he and his doctrine disappeared beneath the waves of the orthodox ocean, and apparently left no trace. For nearly three hundred years longer the full sacred theory held its ground; but about the opening of the sixteenth century another glimpse of the truth was given by a Jew, Elias Levita, and this seems to have had some little effect, at least in keeping the germ of scientific truth alive.

The Reformation, with its renewal of the literal study of the Scriptures, and its transfer of all infallibility from the Church and the Papacy to the letter of the sacred books, did not abate but rather intensified for a time the devotion of Christendom to this sacred theory of language. Only on this one question—the origin of the Hebrew points—was there any controversy, and this waxed hot. It began to be especially noted that these vowel points in the Hebrew Bible seemed unknown to St. Jerome and his compeers; and on this ground, supported by a few other au-

* For Lucretius's statement, see the De Rerum Natura, lib. v, Monro's edition, with translation, Cambridge, 1886, vol. iii, p. 141. For the opinion of Gregory of Nyssa, see Benfey, Geschichte der Sprachwissenschaft in Deutschland, München, 1869; p. 179; and for the passage cited, see Gregory of Nyssa in his Contra Eunomium, xii, Patr. Græca, Paris, 1858, vol. ii, p. 1043. For St. Jerome, see the Epistle, xviii, p. 365, Migne, tome xxii, Paris, 1842. For citation from St. Augustine, see the City of God, Dod's translation, Edinburgh, 1871, vol. ii, p. 122. For citation from Origen, see Homily xi, cited by Guichard in preface to l'Harmonie étymologique, Paris, 1631, lib. xvi, c. xi. For absolutely convincing proofs that the Jews derived the Babel and other legends of their sacred books from the Chaldeans, see George Smith, Chaldean Account of Genesis, *passim;* but especially for a most candid though evidently somewhat reluctant summing up, see page 291.

thorities, some earnest men ventured to think them no part of the original revelation to Adam. Zwingli, so much before most of the Reformers in other respects, was equally so in this. While not doubting the divine origin and preservation of the Hebrew language as a whole, he denied the antiquity of the vocal points, demonstrated their unessential character, and pointed out the fact that St. Jerome makes no mention of them. His denial was long the refuge of those who shared this heresy.

But the full orthodox theory remained established among the vast majority both of Catholics and Protestants. Illustrative of the attitude of the former is the imposing work of the canon Marini, which appeared at Venice in 1593, under the title of Noah's Ark: A New Treasury of the Sacred Tongue. The huge folios begin with the declaration that the Hebrew tongue was "divinely inspired at the very beginning of the world," and the doctrine is steadily maintained that this divine inspiration extended not only to the letters but to the vocal punctuation.

Not before the seventeenth century was well under way do we find a thorough scholar bold enough to gainsay this preposterous doctrine. This new assailant was Capellus, Professor of Hebrew at Saumur; but even he dared not put forth his argument in France. He was obliged to publish it in Holland, and even there such obstacles were thrown in his way that it was ten years before he published another treatise of importance.

The work of Capellus was received by very many open-minded scholars as settling the question, and among these was Hugo Grotius. But many theologians felt this view to be a blow at the sanctity and integrity of the sacred text; and in 1648 the great scholar, John Buxtorf, rose to defend the orthodox citadel: in his Anticritica he brought all his stores of knowledge to defend the doctrine that the rabbinical points and accents had been jotted down by the right hand of God.

The controversy waxed hot; scholars like Voss and Brian Walton supported Capellus. Wasmuth and many others of note were as fierce against him. The Swiss Protestants were especially violent on the orthodox side. The Calvinists of Geneva, in 1678, by a special canon, forbade that any minister should be received into their jurisdiction until he publicly confessed that the Hebrew text, as it to-day exists in the Masoretic copies, is, both as to the consonants and vowel points, divine and authentic.

While in Holland so great a man as Hugo Grotius supported the view of Capellus, and while in France the eminent Catholic scholar Richard Simon, and many others, Catholic and Protestant, took similar ground against this divine origin of the Hebrew punctuation, there was arrayed against them a body apparently overwhelming. In France, Bossuet, the greatest theologian that

France has ever produced, did his best to crush Simon. In Germany, Wasmuth, professor first at Rostock and afterward at Kiel, hurled his "Vindiciæ" at the innovators. Yet at this very moment the battle was clearly won; the arguments of Capellus were irrefragable, and, despite the commands of bishops, the outcries of theologians and the sneering of critics, his application of strictly scientific observation and reasoning carried the day.

Yet a casual observer, long after the fate of the battle was really settled, might have supposed that it was still in doubt. As is not unusual in theologic controversies, attempts were made to galvanize the dead doctrine into the appearance of life. Famous among these attempts was that made as late as the beginning of the eighteenth century by two Bremen theologians, Hase and Iken. They put forth a compilation in two huge folios simultaneously at Leyden and Amsterdam, prominent in which work is the treatise on The Integrity of Scripture, by Johann Andreas Danzius, Professor of Oriental Languages and Senior Member of the Philosophical Faculty of Jena. To preface it, there was a formal and fulsome approval by three eminent professors of theology at Leyden. With great fervor the author pointed out that "religion itself depends absolutely on the infallible inspiration, both verbal and literal, of the Scripture text"; and with impassioned eloquence he assailed the blasphemers who dared question the divine origin of the Hebrew points. But this was really the last great effort. That the case was lost is seen by the fact that Danzius felt obliged to use other missiles than arguments, and especially to call his opponents hard names. From this period the old sacred theory as to the origin of the Hebrew points may be considered as dead and buried.

But the war was soon to be waged on a wider and far more important field. The inspiration of the Hebrew punctuation having been given up, the great orthodox body fell back upon the remainder of the theory, and intrenched this more strongly than ever—the theory that the Hebrew language was the first of all languages, spoken by the Almighty, given by him to Adam, transmitted through Noah to the world after the Deluge, and that the confusion of tongues was the origin of all the other languages of the earth. In giving account of this new phase of the struggle, it is well to go back a little. From the revival of learning and the Reformation had come the renewed study of Hebrew in the fifteenth and sixteenth centuries, and thus the sacred doctrine regarding the divine origin of the Hebrew language received additional authority. All the early Hebrew grammars, from that of Reuchlin down, assert the divine origin and miraculous claims of Hebrew. It is constantly mentioned as "the sacred tongue"—*sancta lingua*. In 1506 Reuchlin, though himself persecuted by a large faction in the Church for advanced views, refers to Hebrew as "spoken by the mouth of God."

This idea was popularized by the 1508 edition of the Margarita Philosophica, published at Strasburg. That work—in its successive editions a mirror of human knowledge at the close of the middle ages and the opening of modern times—contains a curious introduction to the study of Hebrew. In this it is declared that Hebrew was the original speech, "used between God and man and between men and angels." Its full-page frontispiece represents Moses receiving from God the tables of stone written in Hebrew; and, as a conclusive argument, it reminds us that Christ himself, by choosing a Hebrew maid for his mother, made that his mother-tongue.

It must be noted here, however, that Luther, in one of those outbursts of strong sense which so often appear in his career, enforced the explanation that the words "God said" had nothing to do with the voice or articulation of human language. Still, he evidently yielded to the general view. In the Roman Church at the same period we have a typical example of the theologic method in the statement by Luther's great opponent, Cajetan, that the three languages of the inscription on the cross of Calvary "were the representatives of all languages," and he gives as the reason for this the fact that "the number three denotes perfection."

In 1538 Postillus made a very important endeavor at a comparative study of languages, but with the orthodox assumption that all were derived from one source, namely, the Hebrew. Naturally, Comparative Philology blundered and stumbled on in this path with endless absurdities. The most amazing efforts were made to trace back everything to the sacred language. English and Latin dictionaries appeared, in which every word was traced back to a supposed Hebrew root. No supposition was too absurd in this attempt to square Science with Scripture. It was declared that, as Hebrew is written from right to left, it might be read either way, in order to produce a satisfactory etymology. The whole effort in all this sacred scholarship was, not to find what the truth is; not to see how the various languages are to be classified, or from what source they are really derived, but to demonstrate what was supposed necessary to maintain the truth of Scripture, namely, that all languages are derived from the Hebrew.

This stumbling and blundering, under the sway of this orthodox necessity, is seen among the foremost scholars throughout Europe. About the middle of the sixteenth century the great Swiss scholar, Conrad Gesner, beginning his Mithridates, says, "While of all languages Hebrew is the first and oldest, of all is alone pure and unmixed, all the rest are much mixed, for there is none which has not some words derived and corrupted from Hebrew."

Typical, as we approach the end of the sixteenth century, are the utterances of two of the most noted English divines: First of these may be mentioned Dr. William Fulke, Master of Pembroke Hall, in the University of Cambridge. In his Discovery of the Dangerous Rock of the Romish Church, published in 1580, he speaks of "the Hebrew tongue, . . . the first tongue of the world, and for the excellency thereof called 'the holy tongue.'"

Yet more strong, eight years later, was another eminent divine, Dr. William Whitaker, Regius Professor of Divinity and Master of St. John's College at Cambridge. In his Disputation on Holy Scripture, first printed in 1588, he says: "The Hebrew is the most ancient of all languages, and was that which alone prevailed in the world before the Deluge and the erection of the Tower of Babel. For it was this which Adam used and all men before the Flood, as is manifest from the Scriptures, as the Fathers testify." He then proceeds to quote passages on this subject from St. Jerome, St. Augustine, and others. He cites St. Chrysostom in support of the statement that "God himself showed the model and method of writing when he delivered the Law written by his own finger to Moses."*

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* For the whole scriptural argument, embracing the various texts on which the Sacred Science of Philology was founded, with the use made of such texts, see Benfey, Geschichte der Sprachwissenschaft in Deutschland, München, 1869, pp. 22–26. As to the origin of the vowel-points, see Benfey, as above: he holds that they began to be inserted in the second, and that the process lasted until about the tenth century A. D. For Raymundus and his Pugio Fidei, see G. L. Bauer, Prolegomena to his Revision of Glassius's Philologia Sacra, Leipsic, 1795; see especially pp. 8–14, in tome ii of the work. For Zwingli, see Traef. in Apol. comp. Jesaiæ (Opera iii): Cf. e. g. Morinus, De Lingua primæva, p. 447. For Marini, see his Arca Noe: Thesaurus, Linguæ Sanctæ, Venet., 1593, and especially the preface. For general account of Capellus, see G. L. Bauer, in his Prolegomena, as above, Leipsic, 1795, vol. ii, pp. 8–14. His Arcanum Premetationis Revelatum was brought out at Leyden in 1624; his Critica Sacra ten years later. See on Capellus and Swiss theologues, Wolfius, Bibliotheca Nebr., tome ii, p. 27. For the struggle, see Schnedermann, Die Controverse des Ludovicus Capellus mit dem Buxtofen, Leipsic, 1879: cited in article Hebrew, in Encyclopædia Britannica. For Wasmuth, see his Vindiciæ Sanctæ Hebraicæ Scripturæ, Rostock, 1664. For Reuchlin, see the dedicatory preface to his Rudimenta Hebraica, Pforzheim, 1506, folio, in which he speaks of the "in divina scriptura dicendi genus, quale os Dei locutum est." The statement in the Margarita Philosophica as to Hebrew is doubtless based on Reuchlin's Rudimenta Hebraica, which it quotes, and which first appeared in 1506. It is significant that this section disappeared from the Margarita in the following editions; but this disappearance is easily understood when we recall the fact that Gregory Reysch, its author, having become one of the Papal Commission to judge Reuchlin in his quarrel with the Dominicans, thought it prudent to side with the latter, and therefore, doubtless, considered it wise to suppress all evidence of Reuchlin's influence upon his beliefs. All the other editions of the Margarita in my possession are content with teaching, under the head of the Alphabet, that the

This sacred theory entered the seventeenth century in full force, and seems to have swept everything before it. The great commentators, Catholic and Protestant, accepted and developed it. Great prelates, Catholic and Protestant, stood guard over it, favoring those who supported it, doing their best to destroy those who would modify it.

In 1606 Stephen Guichard built new buttresses for it in Catholic France. He explains in his preface that his intention is "to make the reader see in the Hebrew word not only the Greek and Latin, but also the Italian, the Spanish, the French, the German, the Fleming, the English, and many others from all languages." As the merest tyro in philology can now see, the great difficulty that Guichard encounters is in getting from the Hebrew to the Aryan group of languages. How he meets this difficulty may be imagined from his statement, as follows: "As for the derivation of words by addition, subtraction, and inversion of the letters, it is certain that this can and ought thus to be done, if we would find etymologies—a thing which becomes very credible when we consider that the Hebrews wrote from right to left and the Greeks and others from left to right. All the learned recognize such derivations as necessary; . . . and . . . certainly otherwise one could scarcely trace any etymology back to Hebrew."

Of course, by this method of philological juggling, anything could be proved which the author thought necessary to maintain his pious theory.

Two years later, Andrew Willett published at London his Hexapla, or Six-fold Commentary upon Genesis. In this he insists that the one language of all mankind in the beginning "was the Hebrew tongue preserved still in Heber's family." He also takes pains to say that the Tower of Babel "was not so called of Belus, as some have imagined, but of confusion, for so the Hebrew word *ballal* signifieth"; and he quotes from St. Chrysostom to strengthen his position.

In 1627 Dr. Constantine l'Empereur was inducted into the chair of Philosophy of the Sacred Language in the University of

Hebrew letters were invented by Adam. On Luther's view of the words "God said," see Farrar, Language and Languages. For a most valuable statement regarding the clashing opinions at the Reformation, see Max Müller, as above, lecture iv, p. 132. Both Müller and Benfey note, as especially important, the difference between the Church view and the ancient heathen view regarding "barbarians." See Müller, as above, lecture iv, p. 127, and Benfey, as above, p. 170 *et seq.* For a very remarkable list of Bibles printed at an early period, see Benfey, p. 569. For quotation beginning with the words Dictionaries of Latin and English, see Sayce. For Gesner, see his Mithridates (de differentiis linguarum), Zurich, 1555. For a similar attempt to prove that Italian was also derived from Hebrew, see Giambullari, cited in Garlanda, p. 174. For Fulke, see the Parker Society's publications, 1848, p. 224. For Whitaker, see reprint in the Parker Society's publications for 1849, pp. 112–114.

Leyden. In his inaugural oration on The Dignity and Utility of the Hebrew Tongue, he puts himself emphatically on record in favor of the divine origin and miraculous purity of that language. "Who," he says, "can call in question the fact that the Hebrew idiom is coeval with the world itself, save such as seek to win vainglory for their own sophistry by obscuring the truth?"

Two years after Willett, in England, comes the famous Dr. Lightfoot, one of the renowned scholars of his time in Hebrew, Greek, and Latin; but all his scholarship was bent to suit theological requirements. In his "Erubhin," or Miscellanies, published in 1629, he goes to the full length of the sacred theory, though we begin to see a curious endeavor to get over some linguistic difficulties. One passage will serve to show both the robustness of his faith and the acuteness of his reasoning, in view of the difficulties which scholars now began to find in the sacred theory: "Other commendations this tongue (Hebrew) needeth none than what it hath of itself; namely, for sanctity it was the tongue of God; and for antiquity it was the tongue of Adam. God the first founder, and Adam the first speaker of it . . . It began with the world and the Church, and continued and increased in glory till the captivity in Babylon . . . As the man in Seneca, that through sickness lost his memory and forgot his own name, so the Jews, for their sins, lost their language and forgot their own tongue . . . Before the confusion of tongues all the world spoke their tongue and no other; but, since the confusion of the Jews, they speak the language of all the world and not their own."

But just at the middle of the century (1657) came in England a champion of the sacred theory more important than any of these—Brian Walton, Bishop of Chester. His Polyglot Bible, with its prolegomena, dominated English scriptural criticism throughout the remainder of the century. He begins his great work by proving at length the divine origin of Hebrew, and the derivation from it of all other forms of speech. He declares it "probable that the first parent of mankind was the inventor of letters." His chapters on this subject are full of interesting details. He says that the Welshman, Davis, had already tried to prove the Welsh the primitive speech; Wormius, the Danish; Mitilerius, the German; but the bishop stands firmly by the sacred theory, declaring that "even in the New World are found traces of the Hebrew tongue, namely, in New England and in New Belgium, where the word *Aguarda* signifies earth, and the name Joseph is found among the Hurons." As we have seen, Bishop Walton had been forced to give up the inspiration of the rabbinical punctuation, but he seems to have fallen back with all the more tenacity on what remained of the great sacred theory of language, and to have become its leading champion among English-speaking peoples.

At this same period we have the same doctrine put forth by a great authority in Germany. In 1657 Andreas Sennert published his inaugural address as Professor of Sacred Letters and Dean of the Theological Faculty at Wittenberg. All his efforts are given to making Luther's old university a fortress of the orthodox theory. His address, like many others in various parts of Europe, shows that in his time an inaugural with any save an orthodox statement of the theological platform would hardly have been tolerated. There are few things in the past to the sentimental mind more pathetic, to the philosophical mind more natural, and to the progressive mind more ludicrous, than most addresses on such occasions before assemblages of learned theologians at high festivals of great theological schools. The audience has generally consisted mainly of estimable elderly gentlemen, who received their theology in their youth, and who in their old age have watched over it with jealous care to see that it is well coddled and protected from any fresh breeze of thought. Naturally, then, a theological professor inaugurated under these circumstances has endeavored to propitiate his audience. Sennert goes to great lengths both in this and in his grammar, published nine years later, for, declaring the divine origin of Hebrew to be quite beyond controversy, he says: "Noah received it from our first parents, and guarded it in the midst of the waters; Heber and Peleg saved it from the confusion of tongues."

The same doctrine was no less loudly insisted upon by the greatest authority in Switzerland, Buxtorf, professor at Basle, who proclaimed Hebrew to be "the tongue of God, the tongue of angels, the tongue of the prophets"; and the effect of this proclamation may be imagined when we note in 1663 that his book had reached its sixth edition.

It was re-echoed through England, Holland, Germany, France, and America, and, if possible, yet more highly developed. In England Theophilus Gale sets himself to prove that not only all the languages, but all the learning of the world, have been drawn from the Hebrew records.

The orthodox doctrine was also fully vindicated in Holland. Six years before the close of the seventeenth century, Morinus, Doctor of Theology, Professor of Oriental Languages, and pastor at Amsterdam, published his great work on Primæval Language. Its frontispiece depicts the confusion of tongues at Babel, and, as a pendant to this, the pentecostal gift of tongues to the apostles. In the successive chapters of the first book he proves that language could not have come into existence save as a direct gift from heaven; that there is a primitive language, the mother of all the rest; that this primitive language still exists in its pristine purity; that this language is the Hebrew. The second book is devoted to proving that the Hebrew letters were divinely received, have been preserved intact, and are the source of all other alphabets. But in the third book he feels obliged to declare, in the face of the contrary dogma held, as he says, by "not a few most eminent men piously solicitous for the authority of the sacred text," that the Hebrew punctuation was, after all, not of divine inspiration, but a late invention of the rabbis.

France, also, was held to all appearance in complete subjection to the orthodox idea up to the end of the century. In 1697 appeared at Paris perhaps the most learned of all the books written to prove Hebrew the original tongue and source of all others. The Gallican Church was then at the height of its power. Bossuet as bishop, as thinker, and as an adviser of Louis XIV, had crushed all opposition to orthodoxy. The Edict of Nantes had been revoked; and the Huguenots, so far as they could escape, were scattered throughout the world, destined to repay France with interest a thousand-fold during the next two centuries. The bones of the Jansenists were dug up and scattered at Port Royal. Louis XIV stood guard over the piety of his people. It was in the midst of this series of triumphs that Father Louis Thomassin, Priest .of the Oratory, issued his Universal Hebrew Glossary. In this, to use his own language, "the divinity, antiquity, and perpetuity of the Hebrew tongue, with its letters, accents, and other characters," are established forever and beyond all cavil, by proofs drawn from all peoples, kindred, and nations under the sun. This superb, thousand-columned folio was issued from the royal press, and is one of the most imposing monuments of human piety and folly; taking rank with the great treatises of Fromundus against Galileo, of Quaresmius on Lot's Wife, and of Gladstone on Genesis and Geology.

The great theologic-philologic chorus was steadily maintained, and, as in an antiphonal chant, its doctrines were echoed from land to land. From America there came the earnest words of noble John Eliot, praising Hebrew as the most fit to be made a universal language, and declaring it the tongue "which it pleased our Lord Jesus to make use of when he spake from heaven unto Paul." At the close of the seventeenth century comes, as it were, a strong antiphonal answer in this chorus from England. Meric Casaubon, the learned Prebendary of Canterbury, thus declares: "One language, the Hebrew, I hold to be simply and absolutely the source of all." And, to make the chorus perfect, there came into it, in complete unison, the voice of Bentley—the greatest scholar of the old sort whom England has ever produced. He was indeed one of the most learned and acute critics of any age, but he was also Master of Trinity, Archdeacon of Bristol, held two livings besides, and enjoyed the honor of refusing the bishopric of Bristol, as not rich enough to tempt him. *Noblesse oblige:* that Bentley should hold a brief for the theological side was inevitable, and we need not be surprised when we hear him declaring, "We are sure, from the names of persons and places mentioned in Scripture before the Deluge, not to insist upon other arguments, that the Hebrew was the primitive language of mankind, and that it continued pure above three thousand years until the captivity into Babylon." The power of the theologic bias, when properly stimulated with ecclesiastical preferment, could hardly be more perfectly exemplified than in this captivity of such a man as Bentley.

At the beginning of the eighteenth century this sacred doctrine, based, as was supposed, upon explicit statements of Scripture, seemed forever settled. As we have seen, strong fortresses had been built for it in every Christian land; nothing seemed more unlikely than that the little groups of scholars scattered through these various countries could ever prevail against them. These strongholds were built so firmly, and had behind them so vast an army of religionists of every creed, that to conquer them seemed impossible. And yet at that very moment their doom was decreed. Within a few years from this period of their greatest triumph, the garrisons of all these sacred fortresses were in hopeless confusion, and the armies behind them in full retreat; a little later, both the orthodox fortresses and forces were in the hands of the scientific philologists.

How this came about will be shown in the second part of this chapter.*

* The quotation from Guichard is from L'Harmonie étymologique des langues . . . dans laquelle par plusieurs Antiquités et Étymologies de toute sorte, je démonstre évidemment que toutes les langues sont descendues de l'Hébraique; par M. Estienne Guichard, Paris, 1631. The first edition appeared in 1606. For Willett, see his Hexapla, London, 1608, pp. 125–128. For the Address of L'Empereur, see his publication, Leyden, 1627. The quotation from Lightfoot, beginning, "Other commendations," etc., is taken from his Erubhin, or Miscellanies, edition of 1629. See also his works, vol. iv, pp. 46, 47, London, 1822. For Bishop Brian Walton, see the Cambridge edition of his works, 1828, Prolegomena, §§ 1 and 3. As to Walton's giving up the rabbinical points, he mentions in one of the latest editions of his work the fact that Isaac Casaubon, Joseph Scaliger, Isaac Vossius, Grotius, Beza, Luther, Zwingli, Brentz, Œcolampadius, Calvin, and even some of the popes, were with him in this. For Sennert, see his Dissertatio de Ebraicæ S. S. Linguæ Origine, etc., Wittenberg, 1657; also his Grammatica Orientalis, Wittenberg, 1666. For Buxtorf, see the preface to his Thesaurus Grammaticus Linguæ Sanctæ Hebrææ, sixth edition, 1663. For Gale, see his Court of the Gentiles, Oxford, 1672. For Morinus, see his Exercitationes de Lingua Primæva, Utrecht, 1694. For Thomassin, see his Glossarium Universale Hebraicum, Paris, 1697. For John Eliot's utterance, see Mather's Magnalia, Book III, p. 184. For Meric Casaubon, see his De Lingua Anglia Vet., p. 160, cited by Massey, p. 16 of Origin and Progress of Letters. For Bentley, see his works, London, 1836, vol. ii, p. 11,

THE PEOPLING OF AMERICA.*

By M. ARMAND DE QUATREFAGES.

IN acknowledgment of the unexpected honor that has been done me in calling me to this chair, I have first to perform the very pleasant duty of saluting the foreign and French scholars who have responded to the invitation of our committee. I shall do it in few words, but I affirm, in the name of all my colleagues, that they come from the heart. Welcome, gentlemen!

Unluckily, the same honor imposes on me another task, and a difficult one. It is the usage, in opening a session of the Congress, for the president to make an address to his colleagues respecting the questions that are to occupy them; and what can I say, concerning America, to learned men who make that continent the object of their habitual studies? I do not merit, as you do, the title of Americanist. Called by the duties of my teacher's office to deal with the history of all human populations, I can not undertake especially a study which is more than sufficient to absorb a whole lifetime. I have much to learn from you, and I thank you in advance for all that you are going to teach me.

Yet, it is hardly necessary to say, in looking from the point of view of the whole, which has usually been my practice, my thought could not fail to be often directed to that New World the discovery of which opened so many new horizons to nearly all the branches of human knowledge. The question of the origin of its inhabitants appears at the very head of the problems which it sets before the anthropologist. Are the indigenous Americans in any degree relatives of the populations of the other continents? Or, have they appeared on the lands where we have found them, without any ethnological connection with those populations?

You know that both of these opinions have been maintained, and still have their partisans; and I made known long ago the solution which I had reached. In my view, America was origi-

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and citations by Welsford, Mithridates Minor, p. 2. As to Bentley's position as a scholar, see the famous estimate in Macaulay's Essays. For a short but very interesting account of him, see Mark Pattison's article in vol. iii of the last edition of the Encyclopædia Britannica. The position of Pattison as an agnostic dignitary in the English Church eminently fitted him to understand Bentley's career, both as regards the orthodox and the scholastic world. For perhaps the most full and striking account of the manner in which Bentley lorded it in the scholastic world of his time, see Marks's Life of Bentley, vol. ii, chap. xvii, and especially his contemptuous reply to the judges, as given in vol. ii, pp. 211, 212.

* Address before the eighth meeting of the Congress of Americanists.

nally, and has always been, peopled by migrations from the Old World. At the risk of repeating myself, I will briefly sum up the grounds of my conviction.

Permit me first to recall the two rules which I have constantly followed in the solution of the questions, sometimes so ardently contested, which the history of man raises. The first is to put away absolutely every consideration borrowed from dogma or philosophy, and to invoke only science—that is, experiment and observation. The second is, never to isolate man from other organized beings; and to admit that he is subject, as to all that is not exclusively human, to all the general laws which control equally animals and plants. Hence, we can not regard as true any doctrine or opinion which makes man an exception among organized beings.

We make the application of these principles to the question which occupies us, but in a broader way; for it is only a special case of a more general problem which we may formulate in the terms—Man is everywhere now: did he appear everywhere in the beginning? If not absolutely cosmopolitan in its origin, did the race appear at an indefinite number of points? Or, rather, born at a single and limited spot, has it gradually taken possession of the whole earth by migration? At first thought we might suppose that the answer to these questions would be very different according as we admit the existence of one or many human species. That would be a mistake. We purpose to show that polygenists can shake hands with monogenists on this point, without involving themselves in any contradiction. We take, first, the monogenist view.

Physiology, which leads us to recognize the unity of the human race, teaches us nothing in reference to its primary geographical origin. It is otherwise with the science which concerns the distribution of animals and plants over the surface of the globe. The geography of organic beings has also its general facts, which we call laws. These facts—these laws—must be learned and interrogated in order to solve the problem of the manner in which the globe was peopled. The first result of this inquiry is a demonstration that real cosmopolitanism, as we attribute it to man, does not exist anywhere, either in the animal or the vegetable kingdom. I cite a few of the evidences in support of this affirmation.

Take, first, what De Candolle says, that "no phanerogamous plant extends over the whole surface of the earth. There hardly exist more than eighteen the areas of which reach over half the lands; and there is no tree or shrub among the plants of most considerable extension." The last remark touches an order of considerations on which I shall insist further on.

In my lectures on this subject I have cited textually the words of the best authorities among men of science respecting the principal groups of fresh and salt water animals; I have passed in review the fauna of the air, beginning with insects; and have dwelt to some extent on fishes and reptiles. I will spare you the enumeration, and will speak of the bird the area of whose habitat is most extended. The peregrine falcon occupies all the temperate and warm regions of the Old and New Worlds, but does not reach the arctic regions, or Polynesia.

In his body, man is anatomically and physiologically a mammal—no more and no less. This class, therefore, interests us more than the others, and furnishes us with more precise knowledge. I will, for that reason, enter more into detail respecting it, taking as my guide the great work of Andrew Murray.

By virtue of their strength, their enormous locomotive powers, and of the continuity of the seas which they inhabit, the cetaceans should seem to be able to play a truly cosmopolitan part. They do not. Each species is cantoned within an area of greater or less extent, beyond which a few individuals may occasionally make excursions, but always to return soon within their bounds. Two exceptions to this general rule have been noted. A rorqual with large flippers, and a northern *Balænopterus*, natives of temperate and frigid seas, are said to have been found, the first at the Cape, the second at Java. Judging from what Van Beneden and Gervais, the two greatest authorities in cetology, say, these statements are at least doubtful. But, if we accept them as true, it is still the fact that neither species has been met in the seas that wash America and Polynesia. We find nothing else resembling the whales in cosmopolitism, even though it be narrow. Here, also, I spare you the details. You know as well as I do that the species of marsupials, edentates, and pachyderms have their respective countries clearly defined; and that, if the horse and hog are now in America, it is because they have been imported there by Europeans.

A very small number of ruminants inhabit the north of both continents. It is generally agreed to regard the reindeer and the caribou as only races of the same species; Brandt, with some reservations, says as much of the bison and the aurochs, the argali and the big-horn. But none of these species are found in the warm regions of these two quarters, or in all Oceania.

The carnivorous order perhaps offers some similar facts to the preceding. But when we come to the Cheiroptera and the Quadrumana, we do not find a single species common to both continents, or to the rest of the world.

Thus there is not a cosmopolite, after the manner of man, among all organized beings, whether plants or animals. Now, it is evident that the area of the actual habitat of any animal or vegetable species includes the center where that species first appeared. By virtue of the law of expansion, the center should likewise be less in extent than the actual area. No plant and no animal, therefore, originated in all the regions of the globe. To suppose that man appeared in the beginning everywhere that we now see him would be to make a unique exception of him. The hypothesis can not, therefore, be received; and every monogenist must repel the conception of the initial cosmopolitism of the human species as false.

The same conclusion is imposed on polygenists, unless they refuse to apply to man the laws of botanical and zoölogical geography that govern all other beings. In fact, however much they have multiplied species of man—whether they assume that there are two, with Virey; fifteen, with Bery Saint-Vincent; or an undetermined but considerable number, with Gliddon—they have always united them into a single genus. A human genus can be no more cosmopolitan than a human species. Speaking of plants, De Candolle says, "The same causes have borne on genera and on species"; and this is as true of animals as of plants. Limiting ourselves to the animals—among the cetaceans, Murray thinks that the genera of the rorqual and the dolphin are represented in all the seas; Van Beneden and Gervais dispute this; we will, however, admit it, for it will not weaken our conclusions. Besides the cetaceans, there can be no question of generic cosmopolitism. Of the ruminants, the genera of the deer, the ox, etc.; of the carnivores, the cat, dog, bear, etc., have representatives in both worlds, but not in Australia or Polynesia. Further, as we examine the higher and higher groups, we see the number of these genera of large area diminishing. Finally, not a single genus of monkey is known to be common to the old and the new continents; and the simian type itself is wanting in the greater part of both worlds and Oceania.

Thus, whether we regard species or genera, the area of the habitat is the more restricted as the animals are more highly placed in the zoölogical scale. It is the same with plants. De Candolle says on this point, "The mean area of species is as much smaller as the class to which they belong has a more complete, more developed, or, in other words, more perfect organization."

Progressive cantonment, in proportion to the increasing perfection of the organisms, is then a general fact, a law, which is applicable to all organized beings, and which physiology easily accounts for. Now, this law disagrees absolutely with the hypothesis that there can exist a human race, comprehending several distinct species, which have appeared everywhere that we see men. This is easily comprehended. Invoking the authority of Murray, and the universality of habitat which he attributes to the genera of the rorqual and the dolphin, polygenists might be tempted to say: "Non-cosmopolitism already presents two exceptions; why may there not be a third? Two genera of cetaceans are naturally represented in all the seas; why may not the human genus have appeared at the start in every land?"

This reasoning fails at the base. The rorquals and the dolphins belong to the lowest order of mammalia. Men, if we regard the body alone, are the highest order. Unless we constitute them a single exception, they must obey the laws of the superior group; consequently, they can not escape the law of progressive cantonment. It follows, hence, that a human genus, as the polygenists understand it, must have occupied in its origin an area no more extended than that which has devolved on some genera of monkeys. But, among the monkeys themselves, all naturalists recognize a hierarchy; all place at their head the order of the anthropoid apes. It is, then, from the secondary groups of this family that polygenists should ask for indications of the possible extent of the area primarily accorded to the human genus; and you know how inconsiderable is the area of the genera gibbon, orang, gorilla, and chimpanzee. You see that, at whatever point of view we place ourselves, we have either to assume that man alone escapes the laws that have regulated the geographical distribution of all other organized beings, or to admit that the primitive tribes were cantoned upon a very restricted space. By judging from present conditions, by making the largest concessions, by neglecting the incontestable superiority of the human type over the simian type, all that the polygenist hypothesis permits is to regard that area as having been nearly equivalent to that occupied by the different species of gibbons, which range, on the continent, from Assam to Malacca; in the islands, from the Philippines to Java. Monogenism, of course, tends to restrict this area still more, and to make it equal at most to that of the chimpanzee, which extends nearly from Cairo to the Senegal. I am the first to recognize that we may perhaps have to enlarge these limits at some later time. I consider the existence of tertiary man to be demonstrated; and only the geographical distribution of the monkeys, his contemporaries, can furnish more precise information upon the primary extension of the center of man's appearance. Paleontology has taught us that the area formerly occupied by the simian type was evidently more considerable than it is now. It may have been the same with the anthropoid apes. But, till this time, no fossil is connected with that family. You know that the *Dryopithecus*, which was long regarded as belonging to them, has been shown by the examination of the best preserved specimens to be nothing more than a monkey of an inferior order.

At any rate, the general laws of the geographical distribution of beings, and especially that of progressive cantonment, permit us to affirm that man primarily occupied only a very limited part of the globe; and that, if he is now everywhere, it is because he has covered the whole earth with his emigrant tribes.

I know that this thought of the peopling of the globe by migrations troubles many minds. It puts us in the face of an immense unknown; it raises a world of questions, a large number of which may appear to be inaccessible to our research. Thus, I have often been asked: "Why create all these difficulties? It is much more natural to confine ourselves to the popular movements attested by history, and accept autochthonism, especially in the case of the lowest savages. How could the Hottentots and the Fuegians reach their present countries, starting from some undetermined point which you place in the north of Asia? Such voyages are impossible; these peoples were born at the Cape of Good Hope and Cape Horn."

To these conclusions, if not received, I will first answer by an anecdote borrowed from Livingstone, the bearing of which is easy to comprehend. The illustrious traveler tells how in his youth he used to make with his brothers long excursions devoted to natural history. "In one of these exploring tours," he says, "we went into a limestone quarry, long before the study of geology had become as common as it has since. It is impossible to express with what joy and astonishment I set myself to picking out the shells which we found in the carboniferous rock. A quarryman looked at me with that air of compassion which a kindly man takes on at the sight of a person of unsound mind. I asked him how the shells came in the rocks. He answered, 'When God created the rocks, he made the shells and put them there.'" Livingstone adds: "What pains geologists might have spared themselves by adopting the Ottoman philosophy of that workman!" I will ask, in turn, Where would geology have been if men of science had adopted that philosophy? I ask the anthropologists to imitate the geologists; I invite them to inquire how and by what way the most distant peoples have radiated from the center of the first appearance of man to the extremities of the globe. I am not afraid to predict brilliant discoveries to those who will set themselves seriously to the study of numerous well-marked migrations. In this the past permits a glimpse into the future.

Some years ago, when they talked to me in such language as I have just repeated, they did not fail to add Polynesia to the list of regions which men destitute of all our perfected arts could not reach. You know how completely such assertions have been refuted. Adding his personal researches to those of his predecessors, Hale first drew up the map of Polynesian migrations. Twenty years afterward I was able to complete the work of the learned American by the aid of documents collected after the appearance of that, the fundamental study. Now, as has been said by our lamented Gaussin, so competent for all that relates to Oceania, the peopling of Polynesia by migrations starting from the Indian Archipelago is as clearly demonstrated as the invasion of Europe by barbarians in the middle ages.

Like Polynesia, America was peopled by colonists from the Old World. Their point of departure is to be found and their tracks are to be followed. The labor will indeed be more difficult and longer upon the continent than in Oceania, principally because the migrations were more numerous and go back to a higher antiquity. The first Indonesian pioneers, who, departing from the island of Bouro, landed in the Samoan and Tongan Archipelagoes, probably made the passage toward the end of the fifth century, or near the time of the conversion of Clovis. The peopling of New Zealand by emigrants from the Manaias goes back, at most, to the earlier years of the fifteenth century. Thus, the peopling of Polynesia was all accomplished during our middle ages, while the first migrations to America date from geological times.

Two investigators to whom we owe some valuable discoveries, MM. Ameghino and Whitney, have traced the existence of American man back to the Tertiary age. But this opinion, as you know, has been contested by men of equal repute, and I believe that the view of the latter is confirmed by the comparison of the fossil faunas of the pampas, Brazil, and the Californian gravels. Hence, judging by the little that we know, man reached Lombardy and the Cantal when he had not yet penetrated to America. It is undoubtedly necessary at this point to make the most formal reserves with reference to the future; but, if the fact is confirmed, it seems to me to admit of easy explanation. Everything leads me to think that America and Asia were separated previous to the Quaternary age as they are now. Had it been otherwise, the species of mammalia common to the north of both continents would surely have been more numerous. The men and the land animals of the shores of Bering's Sea would have been stopped there. But when the great geological winter rapidly brought in a polar temperature in place of a mild climate like that of our California, the ancient Tertiary tribes were forced to migrate in every direction. A certain number of them embarked upon the bridge of ice which the cold had cast between the two shores, and arrived in America with the reindeer, as their Western congeners arrived in France with the same animal.

From that moment the era of migrations to America was opened. It has never been closed since. Every year the winter rebuilds the bridge which connects East Cape with Cape Prince of Wales; every year a road, comparatively easy for hardy pedestrians, stretches from one continent to the other; and we know that the coast populations of the opposite shores take advantage of it to maintain relations.

Is it not evident that, whenever one of those great movements which we know have agitated Asia made its shocks felt away in distant countries, whenever political or social revolutions overwhelmed them, fugitive or conquered people would have taken this route, of the existence of which they were aware? To get rid of the idea of migrations over the frozen sea, we should have to assume that all the corresponding regions have enjoyed a perpetual peace from the beginning of Quaternary times; but such a peace, you know, is not of this world.

This sea can have been only the principal route followed by the American immigrations. Farther south, the chain formed by the Aleutian Islands and Alaska opens a second route to tribes which have a little skill in navigation. The Aleuts occupy, in Dall's ethnological chart, the whole extremity of the peninsula. By these ways may have taken place what we might call the normal peopling of America. But, bathed on either side by a great ocean, that continent could not fail to profit by the chances of navigation; and we perceive more and more how this must have been the case. We are now justified in saying that Europe and Africa on one side, and Asia and Oceania on the other, have sent to America a number of involuntary colonists, more considerable, probably, than one would be ready to suppose.

The immigrations, in America as in Europe, have been intermittent, and separated sometimes by centuries. America has been peopled as if by a great human river, which, rising in Asia, has traversed the continent from north to south, receiving along its course a few small tributaries. This river resembles the torrent streams of which we have examples in France. Usually, and occasionally for years at a time, their bed is nearly dry. Then some great storm comes, and a liquid avalanche descends from the mountains where their sources lie, covers and ravages the plain, turning over the ancient alluviums, stirring up and mixing the old and new materials, and carrying farther each time the *débris* it has torn up on its passage. Like this has been the career of our ethnological river. Its floods have, besides, often been diverted to the right or left, and it has opened new derivations. It has also had its eddies. But its general direction has not changed, and we can trace it down to the present.

One of the highest tasks of Americanists will be to ascend to the sources of this river; to determine the succession of its freshets; to define the origin and nature of the elements which they have brought down; to follow these elements from stage to stage, and thus discover the road which each of them has followed to its landing-place—in other words, to construct the history of the migrations of the different American peoples.

The accomplishment of this task will, as I have already said, present other and more difficulties in America than in Polynesia. Those who approach it will have recourse to nothing like the historical charts and the genealogies of which are composed the oral archives religiously preserved in all the islands of the Pacific. But modern science has resources of which we are gaining better and better comprehension of the power. Joining the data furnished by the study of the strata and their fossils, by comparative craniology, linguistics, and ethnography, we can enter on the mass of problems and foresee their solution. Serious efforts have been already made in this direction, and they have not been unfruitful. From this time we shall be able to indicate on the map a considerable number of itineraries, but they are so far partial and local. They are as yet no more than fragments, like those which Hale's predecessors could point to in Oceania.

The time may be long in coming, but let not Americanists lose heart. Every new discovery, of however little importance it may seem at first, will bring them nearer to the end. From year to year these fragments, now isolated and scattered, will join and be co-ordinated with one another; and some day the map of American migrations will be delineated, from Asia to Greenland and Cape Horn, as the map of Polynesian migrations has been drawn, from the Indian Archipelago to Easter Island, and from New Zealand to the Sandwich Islands.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

According to M. J. Roche, the telephone was fore-fancied by Charles Boursenl, who said, in 1854: "Imagine that one can speak at a mobile plate so flexible as to lose none of the vibrations produced by the voice, and that this plate in succession establishes and interrupts the communication in an electric pile, and that you have another plate at a distance to execute the same vibrations at exactly the same times. . . . I believe it is certain that, in a more or less distant future, speech will in some such way as this be transmitted to a distance by electricity."

The theory of the European origin of the Aryan race is supported by Canon Isaac Taylor in his book on the origin of the Aryans. Inquiring which of the many races speaking the Aryan languages is the one in which the Aryan form of speech may be presumed to have originated, he numbers four such. They are the Iberians; the race represented by the Swedes and North Germans; the Ligurians, including the Auvergnats and the French Basques; and the Celto Slavic race. As among these, he decides upon the Celto-Slavs as the nearest to the primitive Aryan stock.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

II. IRON MILLS AND PUDDLING-FURNACES.

By WILLIAM F. DURFEE, Engineer.

In these days of steam-engines, railways, and steam navigation—telegraphs, telephones, and electric lights—it is hard to understand a civilization which in literature and the fine arts has not been surpassed, yet had none of the above-named essentials of modern fast living and rapid work, and which possessed no better methods of manufacturing iron than those already described.

It will be evident to the most superficial observer that these methods were not calculated to produce merchantable bar iron either rapidly or cheaply, and this fact would be the more manifest as the bars or rods decreased in size. Therefore, as the requirements of trade were mainly for bars and rods of moderate dimensions, from which to forge nails, draw wire, and manufacture multitudes of the smaller articles of hardware for which the settlement of new countries had created a growing demand, nothing could have been more natural than that the efforts of mankind to meet the requirements of the time should have resulted in the invention of the "slitting-mill." We have no precise information as to the date of this invention, and none whatever respecting its inventor. It is very probable that the slitting-mill was invented in Sweden, and carried thence into Germany, Belgium, and England, whence it found its way to the colony of Massachusetts Bay, where the first "slitting-mill" used in America was put in operation some time prior to 1731. Swedenborg, in his De Ferro (1734), speaks of "slitting-mills" in Sweden, Germany, Belgium, and England, but does not refer to their origin, and says nothing whatever of grooved rolls. Slitting-mills were introduced into England as early as 1697.

A "slitting-mill" comprises two principal mechanisms, which are well illustrated by Fig. 17, which, together with Figs. 16 and 18, we have taken from Recueil de Planches sur les Sciences et les Arts. Paris, 1765. In Fig. 17 will be seen—

1. A pair of plain cylindrical rolls, C D, placed the one above the other, each receiving motion, independent of the other, from a water-wheel, there being one on each side of the mill, whose shafts are seen at E and O. These rolls could be adjusted so that the distance between their adjacent surfaces might be varied within certain limits. These rolls equalized the thickness of the rough forged bar and prepared it for the next operation.

2. The "slitting-mill" proper, seen between the letters N and

V′. This consisted of two horizontal shafts, placed in the same vertical plane with the axes of the rolls D C, and coupled to them by spindles *y* Y′, and coupling boxes *u u′* and V V′. On these shafts were fixed disks of steel, called "*cutters*," of a thickness equal to the width of the bar or rod desired; the edges of the

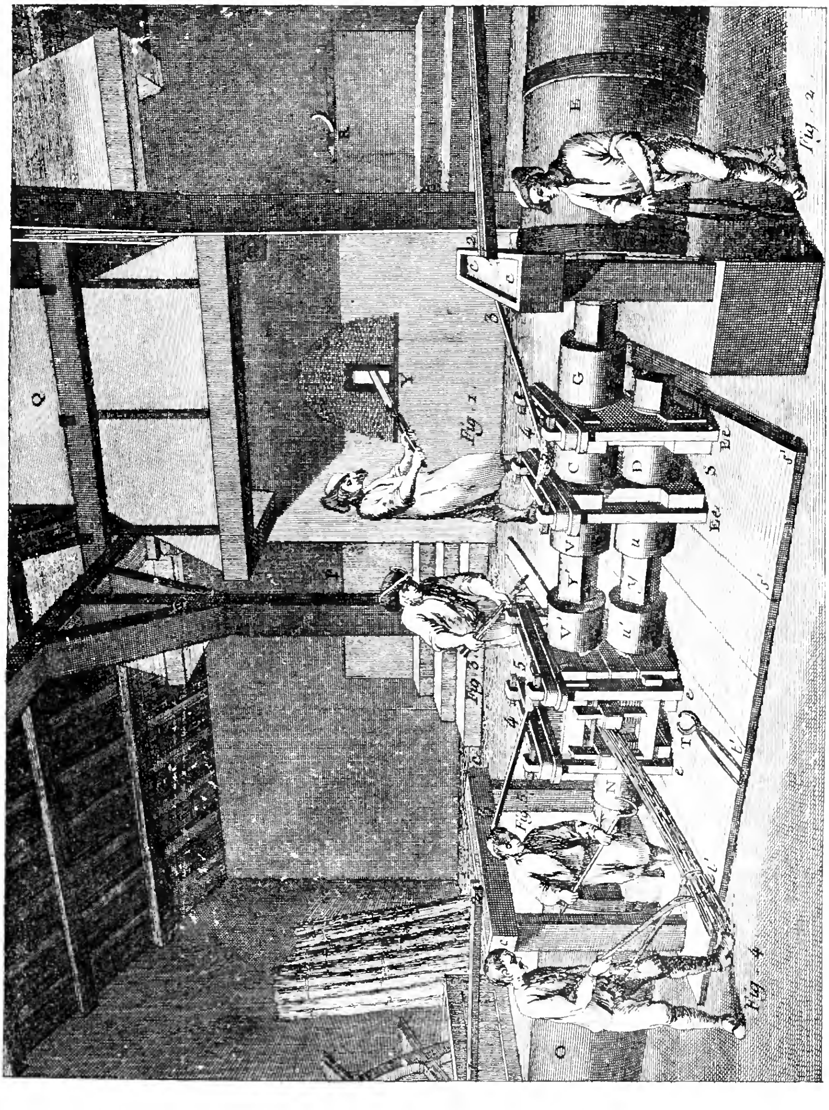

Fig. 17.—Interior of an Early Slitting-Mill. (1764.)

"cutters" on each shaft entered closely between those on the other, thus acting with reference to each other like the blades of rotary shears, which in fact they were; and, if the end of a flat bar of hot iron was thrust against the approaching edges of the rotary cutters, it would be immediately drawn between them, and in its passage it was "sheared" or "slit" (hence the name "slitting-mill") into a number of bars or rods of the same width as the thickness of the cutters in use at the time. The shafts carrying the cutters could be taken from the frames or "housings" in which they revolved, and the cutters could be removed and replaced by others thicker or thinner as desired. The slitting-mill in Fig. 17 gets its motion from the same water-wheel shafts, E O, that drive the rolls C D.

John Houghton, in his Husbandry and Trade Improved, printed in 1697, speaks of rolling and slitting mills as "late improvements"; * speaking of the operation of "slitting" iron bars that have been hammered out in a "blomary," he says: "They are put into a furnace to be heated red-hot to a good height, and then brought singly to the rollers, by which they are drawn even, and to a greater length; after this another workman takes them while hot, and puts them through the *cutters*, which are of divers sizes, and may be put on or off according to pleasure. Then another lays them straight, also while hot, and when cold binds them also into fagots, and then they are fit for sale."

By comparing this description of John Houghton's with Fig. 17, the original of which was published sixty-eight years later, it will be evident that very little change had taken place in the construction of slitting-mills in that period.

The furnace (whose door is seen at Y, in Fig. 17), in which the rough-hammered bars from the "blomary" were heated preparatory to rolling, was peculiarly constructed, and had fire-boxes, P R, on each end. Sections of this furnace are shown in Fig. 18; No. 1 being a longitudinal vertical section through the fire-boxes, P R, and the reverberatory heating-chamber Q; No. 2 a vertical transverse section of the heating-chamber Q, the chimney *q q*, and its hood *q*. It will be observed that the chimney of this furnace is not placed, as in a modern iron heating-furnace, at one end of the heating-chamber, while the fire-box is at the other; but that it is located outside and in a measure detached from the body of the furnace, and that the products of the combustion of the wood (which was the only fuel used) burned

* The earliest publication known to me, in which the use of "rolls" for drawing and shaping metals is described, was written by Giovanni Branca. In his work, Le Machine (published at Rome in 1629), he gives a very curious illustration of a rolling-mill, which, notwithstanding its manifest absurdity, suffices to show that he understood the action of the "rolls" and their advantages. The next mention of the use of rolls for giving shape to metals passed between them is contained in a work by Vittorio Zonca, published at Padua in 1656. In this work Zonca gives an engraving and description of a mill for rolling the double grooved fillets of lead which were used for securing the glass in stained windows. We regret that our limited space prevents us from reproducing these illustrations, neither of which has ever been referred to in any history of the manufacture of metals.

in the two fire-boxes P R, after traversing the heating-chamber Q, could only reach the chimney by passing out of the door Y. This arrangement was not calculated to produce a very rapid combustion of the fuel, and therefore large fire-boxes were necessary. The dimensions of this furnace would not be thought small even at the present time, for the heating-chamber Q was ten and a half feet long and seven feet wide, and the two fire-boxes were each four feet square.

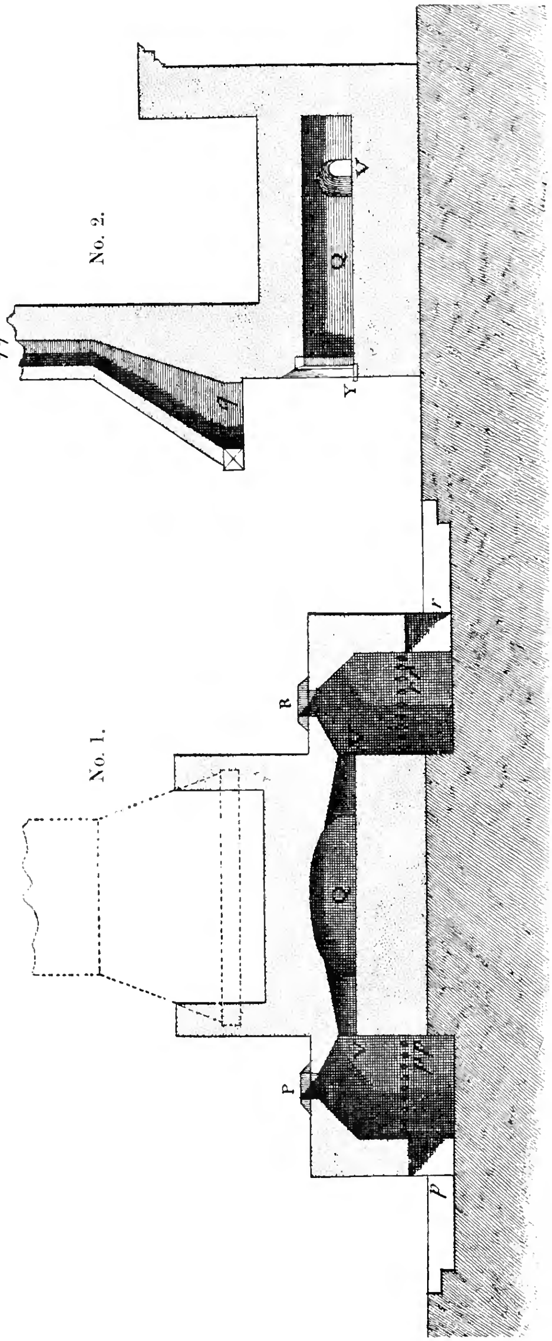

Fig. 18.—Longitudinal and Transverse Sections of Heating Furnace in a Slitting-Mill. (1764.)

The above construction of slitting-mills was not the initial form; for in that, the axes of the rolls and cutters, instead of being in the same, were in parallel planes, and instead of being driven directly from the water-wheels, there was interposed between the water-wheel shafts and those of the rolls and cutters some clumsy wooden gearing. Fig. 19 (from Swedenborg) shows a

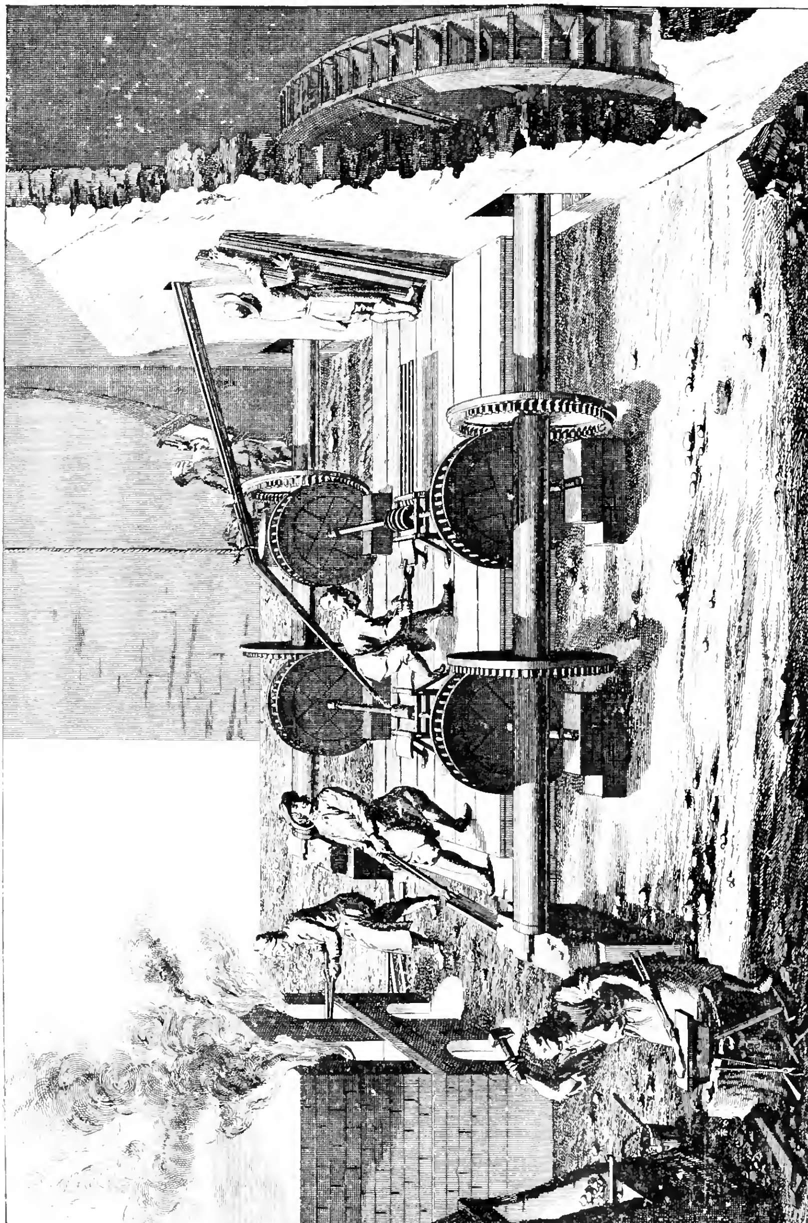

Fig. 19.—Old Form of Slitting-Mill in Use in Sweden in 1734.

mill of this kind. It will be noted that the top roll and set of cutters were driven from one water-wheel, and the bottom roll and cutters from another; it will also be observed that the iron was evidently heated directly upon the coal. Swedenborg says: "In the vicinity of Liége are a few works in which iron is rolled out and cut into small rods; and in Germany and England there is similar machinery, constructed as shown in Fig. 19, which vividly represents the whole operation.

"The furnace shown is simply constructed, and is divided into two parts, beneath each of which is an ash-pit. The iron is thrown into the furnace upon the mineral coal (*carbones fossiles*) and the bars are placed across one another obliquely, so that the flame and heat will have access to all sides of them. The roof of the furnace is formed into an arch. When the pieces of iron are heated by the direct action of the coal, and by the heat reverberated from the roof of the furnace, they are removed and run through two steel rolls."

By comparing this mill and furnace with those illustrated in Figs. 17 and 18, it will be evident that in the thirty-one years which intervened between the publication of De Ferro and Recueil de Planches sur les Sciences et les Arts important progress had been made in the construction of both mills and furnaces.

We have been thus particular in explaining the construction of the early European slitting-mills because it is certain that many of the ideas embodied in the first American slitting-mill were derived therefrom.

Industrial history is indebted to William H. Harrison, of Braintree, Mass., for the preservation of a record of the details of construction of certainly one of the earliest, if not actually the first, rolling and slitting mills built in America.* The general plan and elevation of the machinery, as also of the furnace employed in this mill, are shown in Fig. 20, and it will be noted that the natural tendency of the American mechanician to improve on what had already been accomplished asserted itself in this case. The designer while retaining many features of previous mills—such as wooden gearing, the use of two under-shot water-wheels, one of which drove the top set of cutters and the bottom roll, while the other drove the bottom set of cutters and the top roll—yet made some important improvements in the rolls by increasing their length and making offsets in them † by which iron of varying thickness could be made without changing their adjustment: and he also "chilled" one end of the rolls.‡ The furnace was a marked improvement over any before described, and was quite similar in idea to many in use at the present day: it had a "fire-box" (in which "*pine sticks*" were used as fuel), a "heating-chamber," and a "chimney." This mill was erected "at Middle-

* The First Rolling-Mill in America. A Paper read by William H. Harrison, M. E., at the Hartford Meeting of the American Society of Mechanical Engineers, May 4, 1881.

† A very close approximation to the "grooved roll."

‡ This is believed to be, if not the first "chilled roll" made, yet the first mentioned in rolling-mill construction.

boro, Mass., for Peter Oliver, one of the crown Judges in the province, and a brother of Andrew Oliver, the Lieutenant-Governor, in the year 1751."

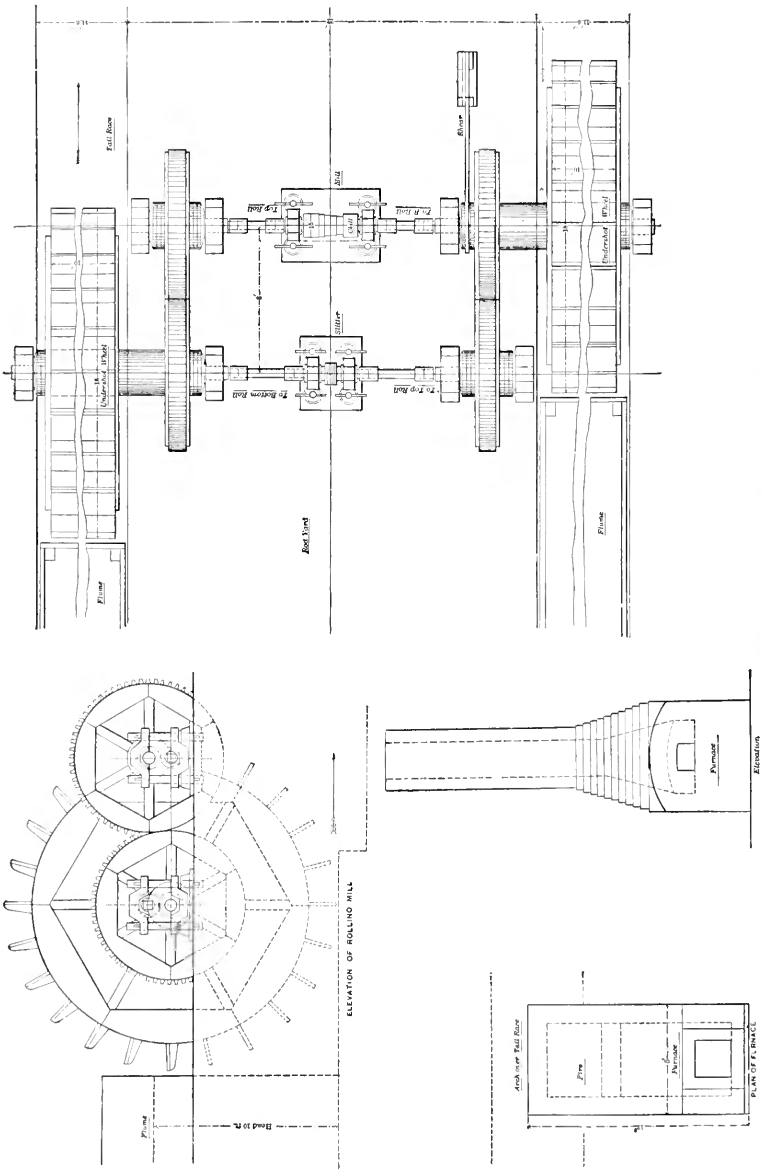

Fig. 20.—Plan of a Rolling-Mill Built at Middleboro, Mass., in 1751.

Mr. Harrison says, in concluding his very interesting paper: "The drawing was made under the supervision of S. Wilder, Esq., of New Castle, Pa., a retired iron manufacturer, who worked in this mill in 1818, and gave the writer the principal dimensions and the method of operating. As to whether this mill—in the year 1818—was precisely the one built in 1751, Mr. Wilder states that it is likely there had been some renewals of the wood-work, but most of the iron-work was the original. It was impossible to break down the mill, from the fact that, if a heavy piece or a pair of tongs were passed in, the effect would be—after some squeaking of the timber-wheels—to stop everything."

The claim made that this rolling-mill was the first in America can not be substantiated, for, according to the evidence adduced, it was not erected until 1751; but it is certain that there were already several slitting-mills in operation in the colonies, as is proved by the certificates transmitted to the Commissioners for Trade and Plantations by the Governors, Lieutenant-Governors, or commanders-in-chief of his Majesty's colonies in America, in pursuance of an act of the twenty-third of his present Majesty's [George II, 1750] reign, containing accounts of any mill or engine for slitting or rolling of iron, and any plating-forge to work with a tilt-hammer, and any furnace for making steel, erected in any of his Majesty's colonies in America":

	Mill or engine for slitting or rolling iron.	Plating forge to work with a tilt-hammer.	Furnace for making steel.
Maryland	....	1, with two tilt-hammers.	....
Pennsylvania..........	1	1	2
New Jersey...........	1, not now in use.	1, not now in use.	1, not now in use.
New York...........	....	1 " "	....
Connecticut	....	1, 1, 1, 1, 1, 1	1
Massachusetts Bay.....	1, 1	1	1 *

By these certificates of 1750 it appears that in all the colonies there were four slitting-mills, two of which were in Massachusetts; and as Judge Peter Oliver's mill was not erected ("by special privilege") until 1751, it could not have been one of them, and for the same reason it is certain that it was not the first rolling-mill in America. Nevertheless the paper of Mr. Harrison is instructive and valuable, inasmuch as it gives us the only reliable technical information we have relative to the construction and operation of rolling and slitting mills in colonial times. In addition to the leading constructive features of this mill, we are given some facts regarding its administration, and are told that "about eight men were employed, at about one dollar per day; six heats, of about eight hundred pounds each, were made in twelve hours' running. One pint of rum was consumed for each heat, or more, according to the weather. The value of the forge iron was one hundred dollars per ton; nail-rods, one

* A Comprehensive History of the Iron Trade throughout the World, from the Earliest Records to the Present Period. By Harry Scrivenor. London, 1841.

hundred and twenty dollars; and nails, twelve and a half cents or ninepence per pound. The nail-rods were put up in bundles of fifty-six pounds, and the nailers, who had their little shops around in the country, were expected to bring back fifty pounds of headed and pointed nails, receiving "store-pay" of calico, tea, rum, etc.

From this account it appears that "rum," in quantity proportioned "to the weather," was regarded as a necessary stimulant, to be furnished the workmen to enable them to properly perform their work. This custom, which was in fact universal in New England at the time, seems to have had the sanction of several generations, for the New Haven colonial records tell us that "a proposition made in May, 1662, 'in y^e^ behalfe of Capt. Clarke, that wine and liquors drawn at the jron workes might be custome free,' was allowed to the extent of one butt of wine and one barrel of liquors, and no more."

The act of 1750 was pretty generally enforced in the colonies, and the further erection of rolling and slitting mills prevented. James Hamilton, Lieutenant-Governor and Commander-in-Chief of the Province of Pennsylvania, and William Franklin (son of Benjamin Franklin), who was the royal Governor of the Province of New Jersey (1762 to 1776), were especially zealous in enforcing this act. Hon. Edward D. Halsey, in his History of Morris County, tells us that "a slitting-mill was erected at Old Boonton, on the Rockaway River, about a mile below the present town of Boonton, in defiance of the law, by Samuel Ogden, of Newark. The entrance was from the hill-side, and in the upper room first entered there were stones for grinding grain, the slitting-mill being below and out of sight. It is said that Governor William Franklin visited the place suddenly, having heard a rumor of its existence, but was so hospitably entertained by Mr. Ogden, and the iron-works were so effectually concealed, that the Governor came away saying that he was glad to find that it was a groundless report, as he had always supposed."

From the passage of the act of 1750 to the Revolution the iron industry of America was chiefly confined to the manufacture of pig and bar iron in the furnaces, forges, and mills already erected, and of castings from the blast-furnaces.

Israel Acrelius (who visited America in 1750–1756), in his History of New Sweden, when describing the iron-works of Pennsylvania, says: "The workmen are partly English and partly Irish, with some few Germans, though the work is carried on after the English method. The pig iron is smelted into 'geese' (*gäsar*), and is cast from five to six feet long and a half foot broad, for convenience of forging, which is in the Walloon style. The pigs are first operated upon by the finers (smelters). Then the chiffery, or hammer-men, take it back again into their hands and beat out the long bars. The finers are paid 30*s.* a ton, the hammer-men 23*s.* 9*d.* per ton—that is to say, both together, £2 13*s.* 9*d.* The laborers are generally composed partly of negroes (slaves), partly of servants from Germany or Ireland bought for a term of years. . . . For four months in summer, when the heat is the most oppressive, all labor is suspended at the furnaces and forges."

About 1732 Colonel Spotswood erected some air-furnaces at a place called Massaponux, in Virginia, and used them "to melt his sow iron, in order to cast it into sundry utensils, such as backs for chimneys, andirons, fenders, plates for hearths, pots, mortars, rollers for gardeners, skillets, boxes for cart-wheels, and many other things. And, being cast from the sow iron, are much better than those which come from England, which are cast immediately from the ore for the most part. . . . Here are two of these air-furnaces in one room, that so in case one want repair the other may work, they being exactly of the same structure." It is said that in 1760 about six hundred tons of iron were smelted in Spotswood's furnaces, most of which was sent to England.

About 1750 Baron Henry William Stiegel came to Pennsylvania from Germany, "with good recommendations and a great deal of money." Soon after he purchased a tract of land in Lancaster County and laid out the town of Manheim; here he built a furnace, and named it after his wife, Elizabeth; some time afterward he built another furnace at Schaefferstown, Lebanon County, and it was here that he cast stoves (made of six plates of iron), which were among the first made in the country. The baron fully appreciated the value of advertising, and on each of the stoves he cast the following couplet:

"Baron Stiegel ist der Mann,
Der die Ofen machen kann"—

which signifies, "Baron Stiegel is the man who knows how to make stoves"; but, notwithstanding his skill and enterprise, he failed in his business. This result was due in a great degree to the difficulty of making prompt collections, and to the general stagnation of business due to the political complications with the mother-country. Elizabeth Furnace finally came into the possession of Robert Coleman, who cast shot, shells, and cannon for the Continental army. Some of the credits in his account with the Government are decidedly interesting. On November 16, 1782, appears the following entry: "By cash, being the value of 42 German prisoners of war, at £30 each, £1,260," and on June 14, 1783: "By cash, being the value of 28 German prisoners of war, at £30 each, £840."

During the Revolutionary War the manufacture of iron made little technological progress. Such establishments as possessed the requisite skill cast cannon and mortars, and the iron ammunition for the same, for that army which controlled them for the time being. One of the most notable events connected with the manufacture of iron during these years was the making of the great iron chain which in 1778 was stretched across the Hudson River at West Point to prevent the passage of British vessels. Lossing, in his Field Book of the Revolution, gives a very interesting account of this work, of which we can quote only the leading facts. "The iron of which this chain was constructed was wrought from ore of equal parts from the Sterling and Long mines in Orange County. The chain was manufactured by Peter Townsend, of Chester, at the Sterling Iron Works in the same county, which were situated about twenty-five miles back of West Point. The chain was completed about the middle of April, 1778, and on the 1st of May it was stretched across the river and secured. It was fixed to huge blocks on each shore, and under cover of batteries on both sides of the river." "It is buoyed up," says Dr. Thacher, writing in 1780, "by very large logs of about sixteen feet long, pointed at the ends, to lessen their opposition to the force of the current at flood and ebb tide. The logs are placed at short distances from each other, the chain carried over them, and made fast to each by staples. There are also a number of anchors dropped at proper distances, with cables made fast to the chain to give it greater stability." The total weight of this chain was one hundred and eighty tons. Mr. Lossing visited West Point in 1848, and saw a portion of this famous chain, and he tells us that "there are twelve links, two clevises, and a portion of a link remaining. The links are made of iron bars, two and a half inches square, and average in length a little over two feet, and weigh about one hundred pounds each."

The manufacture of nails was one of the household industries of New England during a large part of the eighteenth century. James M. Swank, in Iron in All Ages, quotes from Nehemiah Bennet's description of the Town of Middleborough, Plymouth County, Massachusetts (1793): "Nailing, or the business of making nails, is carried on largely in the winters, by farmers and young men, who have little other business at that season of the year." Speaking of the early attempts to manufacture tacks, the same authority gives the following from the Furniture and Trade Journal: "In the queer-shaped, homely farm-houses, or the little contracted shops of certain New England villages, the industrious and frugal descendants of the Pilgrims toiled providently through the long winter months at beating into shape the little nails which play so useful a part in modern industry. A small anvil served to beat the wire or strip of iron into shape and point it; a vise worked by the foot clutched it between jaws furnished with a gauge to regulate the length, leaving a certain portion projecting, which, when beaten flat by a hammer, formed the head. By this process a man might make, toilsomely, perhaps two thousand tacks per day." Arnold, in his History of the State of Rhode Island, claims that "the first cold-cut nail in the world was made in 1777 by Jeremiah Wilkinson, of Cumberland, R. I., who died in 1832, at the advanced age of ninety years." Bishop, speaking of Wilkinson's tacks, says: "They were first cut by a pair of shears (still preserved) from an old chest-lock, and afterwards headed in a smith's vise. Sheet iron was afterwards used, and the process extended to small nails, which he appears to have been one of the first to attempt. They were cut from old Spanish hoops, and headed in a clamp or vise by hand. Pins and needles were made by the same person during the Revolution from wire drawn by himself." Such was the genesis of the manufacture of nails in America; an industry now of the first importance, and which in 1889, after the lapse of little more than a century, produced over *eight hundred million pounds* of iron, steel, and wire nails, representing a consumption of this absolutely indispensable manufacture, for the past year, at the rate of over *twelve pounds* for each individual inhabitant of the United States. As nails enter as a component factor into all structures for domestic, manufacturing, and trade uses, this enormous consumption may be taken as a fair index of the development of the country during the past hundred years.

The adoption of the Constitution in 1787, followed by the enactment of the first national patent law in 1790 (previous to the establishment of a national government the several colonies had issued patents for meritorious inventions), powerfully stimulated the inventive genius of the people, and it soon became evident that America was destined to surpass all other nations in the invention and manufacture of labor-saving machinery.

One of the most important improvements in the manufacture of articles of metal, of which a large number were required of the same kind, was developed by Eli Whitney, the inventor of the cotton-gin, who, disappointed in his expectations relative to that machine, turned to the manufacture of small-arms for the United States Government. In 1798 he erected at Whitneyville, near New Haven, Conn., the first manufactory of fire-arms in which each part was made so exactly to the prescribed dimensions that it would fit its intended place in any one of thousands of muskets. Mr. Whitney not only conceived the ideas of the possibility and economic advantages of such perfect workmanship, but invented the system and much of the machinery by which it was practically accomplished. "Whitney's interchangeable system" has been applied successfully to the manufacture of clocks and watches, sewing-machines and steam-engines, and is universally recognized as indispensable whenever accuracy and economy are to be combined with a large production.

Swank gives the following description of the Sterling Iron Works (already mentioned as the place where the West Point chain was forged), translated from a book published in Paris in 1801, written by the Marquis de Crevecœur, who was in the French service in the French and Indian War and afterward traveled extensively in this country:

"Hardly had we put our horses in the stable than Mr. Townsend, the proprietor, came to meet us with the politeness of a man of the world. Having learned that the object of our journey was to examine attentively his different works, he offered to show us all the details, and at once led us to his large furnace where the ore was melted and converted into pigs of sixty to one hundred pounds weight. The blast was supplied by two immense wooden blowers, neither iron nor leather being used in their construction. This furnace, he said, produced from two thousand to twenty-four hundred tons annually, three fourths of which are converted into bars, the rest melted into cannon and cannon-balls, etc. From there we went to see the forge. Six large hammers were occupied in forging bar iron and anchors and various pieces used on vessels. Lower down the stream (which afforded power to the works) was the foundry with its reverberatory furnace (air-furnace). Here he called our attention to several ingenious machines destined for different uses. The models he had sent him, and the machines he had cast from iron of a recently discovered ore, which, after two fusions, acquired great fineness; with it he could make the lightest and most delicate work. 'What a pity,' he said, 'that you did not come ten days sooner! I would have shown you, first, three new styles of plows, of which I have cast the largest pieces, and which, however, are no heavier than the old-fashioned. Each of them is provided with a kind of steelyard, so graduated that one can tell the power of the team and the resistance of the soil; second, I would have shown you a portable mill for separating the grain from the chaff; followed by another machine by which all the ears in the field can be easily gathered without being obliged to cut the stalk at the foot, according to the old method.' From the foundry we went to see the furnaces where the iron is converted into steel. 'It is not as good as the Swedes',' said Mr. Townsend, 'but we approach it—a few years more of experience and we will arrive at perfection. The iron which comes from under my hammers has had for a long time a high reputation, and sells for £28 to £30 per ton.' After having passed two days in examining these diverse works and admiring the skill with which they were supplied with water, as well as the arrangements for furnishing the charcoal for the different furnaces, we parted from Mr. Townsend."

On June 27, 1810, Mr. Clemens Rentgen, of Pikeland, Chester County, Pennsylvania, obtained a patent for "rolling iron round, for ships' bolts, and other uses," by the following method: "This machine consists of two large iron rollers, fixed in a strong frame. Each roller has concavities turned in them, meeting each other to form perfectly round bolts, of from half an inch to one and three quarter inches, or any other size, in diameter, through which rollers the iron is drawn from the mouth of the furnace with great dispatch, and the iron is then manufactured better and more even than it is possible to forge it out. The force applied to the end of these rollers is like that applied to mills."

Swank states that W. H. Wahl, Ph. D., Secretary of the Franklin Institute (who is a descendant of Mr. Rentgen), showed him the original patent, and informed him that Mr. Rentgen "rolled round iron as early as 1812 or 1813, some of which was for the Navy Department of the United States Government"; and he adds, "The fact that a patent was granted to him as late as June 27, 1810, for a machine to roll iron in round shapes, would seem to furnish conclusive proof that Cort's rolls* had not then been introduced into the United States." About the beginning of the present century the steam-engine (two or three steam-engines had been imported and used for draining mines prior to the Revolutionary War) as a motive power for driving mills and factories began to attract attention. The period of its introduction is worthy of mention, as it has played a very important part in the development of the iron and steel industries of this country.

According to Swank, "the first rolling-mill erected in the United States to 'puddle' iron, and roll it into bars, was built by Col. Isaac Meason, in 1816 and 1817, at Plumsock, on Redstone Creek, in Fayette County, Pennsylvania. Thomas C. Lewis was the chief engineer in the erection of the mill, and George Lewis, his brother, was the turner and roller. They were Welshmen. . . . The mill contained two 'puddling furnaces,' one 'heating furnace,' one 'refinery,' and one 'tilt-hammer.' Raw coal was used in the 'puddling' and 'heating furnaces,' and coke in the 'refinery.'"

In the early practice in this country the operation of "puddling," by which cast iron is converted into wrought iron, was usually preceded by a process called "refining," which was effected by means of an apparatus called a "refinery"—a vertical section of one of the latest and best forms of which is shown in Fig. 21.

* Cort's patent was taken out in 1783, but the evidence is sufficient and conclusive as to a somewhat extended knowledge and use of grooved rolls on the continent of Europe many years prior to that date.

It consisted of a basin or hearth, *b*, in which a fire of charcoal or coke was built, the fuel being carried above the level of the water-cooled *tuyères*, *g g*. On this mass of ignited fuel a charge of a ton or a ton and a half of pig iron was thrown, over which fuel was heaped, and the blast (which was regulated by the valves, *k k*) was then turned on. In about one hour and a half the pig iron was melted, and its upper surface as it lay in the hearth was exposed to the action of the blast (oftentimes in the larger refineries there were six *tuyères*, three on a side, but in some of the oldest refineries there was but one *tuyère*); this effected the oxidation and removal of considerable of the carbon, most of the silicon, and a portion of the sulphur, a large amount of "slag" being formed. About two hours after the commencement of the operation the metal was "tapped out" on to the "running-out bed," which was a shallow trough made of very thick castings; a section of which is shown at *n*. These castings were provided with flanges, which rested upon the sides, *o o*, of a box or channel, *p*, filled with water to cool the running-out bed, and promote the rapid solidification of the liquid refined iron; and as soon as this was accomplished the final cooling was hastened by a jet of water forcibly thrown upon the upper surface of the metal from a hose. This caused the "cinder" on this surface to separate in a great degree from the refined metal, which, when perfectly cool, was broken up into pieces of manageable size. The fracture of "refined metal" was white, inclined to

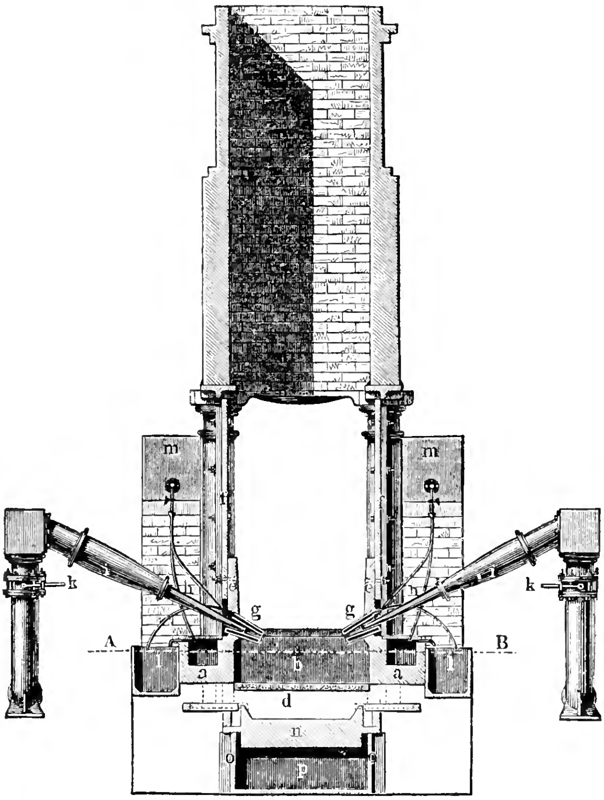

Fig. 21.—Cross-section of a Refinery.

a silvery luster, and oftentimes more or less porous or "honey-combed" near the upper surface, The purpose of this "refining" was, as the name suggests, the purification of the metal previous to its being treated in a puddling-furnace for final conversion into wrought iron. At the present day the "refinery" is rarely employed, improved methods having rendered it unnecessary.

The invention of the "puddling process" is usually ascribed to Henry Cort, of Gosport, England, who patented it in 1784. This process was a great improvement over that of the "blomary fire," inasmuch as the labor was diminished, and, as the metal was not in contact with the fuel, therefore raw mineral coal, which was much cheaper than charcoal, could be used with natural draught, thus dispensing with all blowing machinery. The process, as practiced on its introduction into America, consisted substantially of melting refined pig iron on the sand bottom of a reverberatory furnace, and stirring the pool (or "puddle," whence the name of the process) of molten metal until it became converted into a granular, pasty mass of wrought or forgeable iron, as the result of the decarbonizing action of the heated air passing through the furnace and over the metal. This granular mass of metal was divided by the "puddler" (as the workman was called) into several separate "balls," or "loups," which were taken in turn to a "shingling hammer," and "shingled" into "blooms"; this last operation being precisely similar to the shingling of the "ball" from a blomary fire, already described.

Figs. 22 and 23 are respectively vertical and horizontal longitudinal sections of one of the earlier forms of "puddling-furnace," in which *e* is the sand bed of the puddling-chamber, *d* the "bridge-wall" which separated the fuel on the grates *b* of the "fire-box" from the iron in the puddling-chamber *e*, *i* is the chimney-flue, and *k* a lever for raising the door *j*. In some of the early puddling-furnaces in New England and eastern Pennsylvania the fuel used was dry split wood; and as late as 1858 dry pine wood was used for puddling and heating at the Hurricane Rolling-Mill and Nail-Works in South Carolina. This was probably the last instance of the use of wood as a fuel for such purposes in the United States.

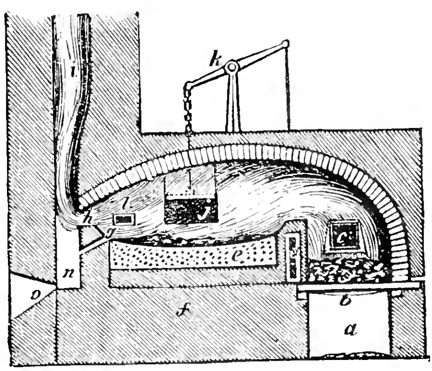

FIG. 22.—AN EARLY PUDDLING-FURNACE.

Soon after the introduction of the puddling process into this country, Mr. Samuel Baldwyn Rogers, of Nant-y-glo, Monmouthshire, England, made very important improvements in the construction of puddling-furnaces, by substituting iron plates for the original sand bottoms of their puddling-chambers; and in the conduct of the process, by using iron-ore as the chief source of the oxygen necessary to decarburize the melted pig iron. This ore was packed around the sides of the interior of the furnace, and the bottom plates were protected by a layer of oxide of iron. These improvements more than doubled the daily production from a furnace, and at the same time a superior quality of iron was made.

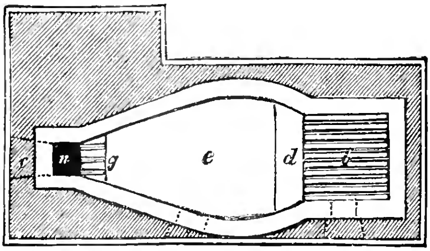

Fig. 23.—Plan of an Early Puddling-Furnace.

Mr. Rogers encountered a great deal of ridicule in attempting to introduce these improvements, which were pronounced impracticable and of no value by many of the leading iron-masters of England; and, as he failed to protect his rights by patents, the only reward that he ever received for inventions that have been of vast benefit to mankind was the nickname "Old Iron Bottoms," which was bestowed upon him by those of his contemporaries who fully believed that they had become possessed of all desirable knowledge, and were, in fact, too wise to learn. Unfortunately for our country, a few of the descendants of these wise fools, who were patriotic enough to "leave their country for their country's good," found their way to America, and are honoring their ancestry by sneering at all ideas and methods that are not hoary with antiquity and moldy respectability. In spite of such counsels in the past, the improvements of Mr. Rogers found their way into use in America and the world at large, and for the last fifty years there has not been a puddling-furnace as originally constructed by Cort in existence.

A very good idea of the appearance and construction of the puddling-furnace in common use in the "puddle-mills" of England and America is conveyed by Figs. 24 and 25. Fig. 24 is a side elevation of the furnace, whose interior form is shown by dotted lines. The whole of the brick-work is inclosed in a casing of cast-iron plates, securely bolted together. The door of the working-chamber is seen in the center (and at C, Fig. 25), counterbalanced and operated by a lever and chain, and below it the "tap-hole," by which the "cinder" made in the process is "tapped off"; to the left is seen the "stoke-hole," and just to the right of it is shown, in dotted lines, the outline of the "bridge-wall" separating the "fire-box" on the left from the "working-chamber" in the center of the furnace. The chimney (shown at the right of the cut, broken in three places for convenience of illustration) is usually from thirty to forty feet in height, provided with a damper operated by a lever at its top, and its flue is usually eighteen inches square. Fig. 25 is a section of the furnace (on line G, H, Fig. 24), showing the form of its interior in plan, and the relative position of "fire-grate," "working-chamber," and "chimney-stack." In mills driven by steam power it is not now uncommon to place a horizontal cylindrical flue-boiler over each puddling and heating furnace, and generate the steam required to run the mill by passing the heat, that would otherwise go to waste up the chimney, underneath the boiler, and thence through the flues to the chimney-stack. This construction was the invention of the late John Griffen, who at the time of his death (January 14, 1884) was General Superintendent of the Phœnix Iron Company at Phœnixville, Pa. The idea of utilizing the waste heat of puddling and heating

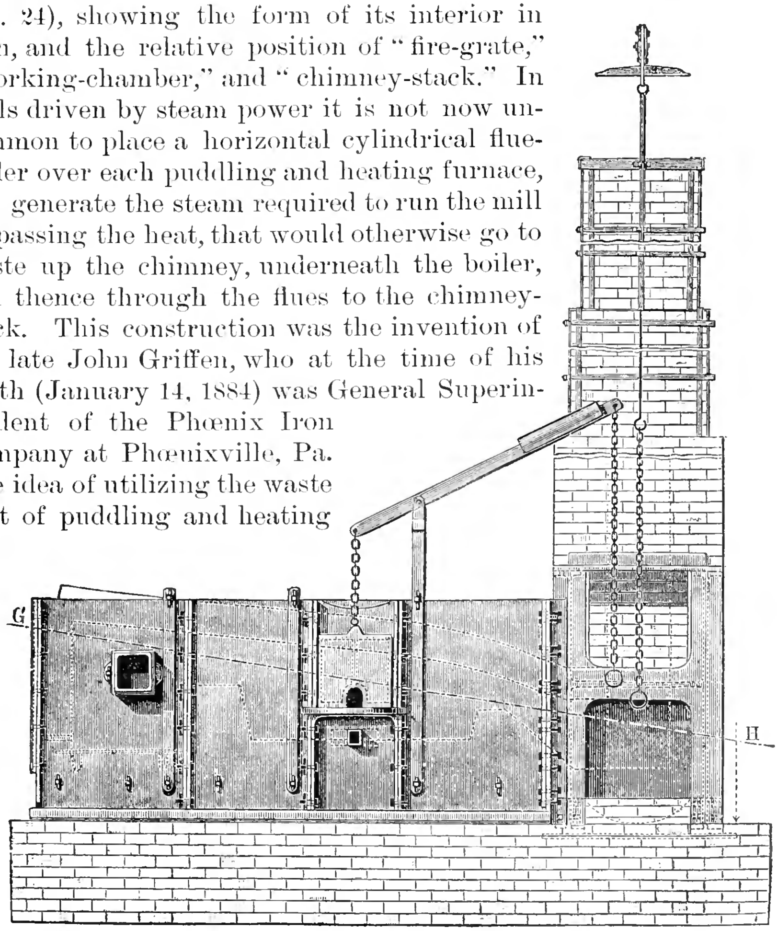

FIG. 24.—A MODERN PUDDLING-FURNACE.

furnaces for the making of steam was, however, quite old at the time he brought out his arrangement.

When, in 1846, Mr. Griffen erected at Norristown, Pa., for Messrs. Moore & Hooven, the first mill in which all the steam was generated in boilers placed over the furnaces, the wise fools were in strong force; and Swank tells us that "Mr. Griffen met with much opposition from observers while employed in constructing the mill upon this plan, and many predictions were made that the new arrangement would prove a failure. It was a great innovation on the practice then prevailing, but it was a complete success." Whereat the wise fools who had been posing as "observers," promptly swallowed all their observations, and with the characteristic agility of their race turned each a back somerset,

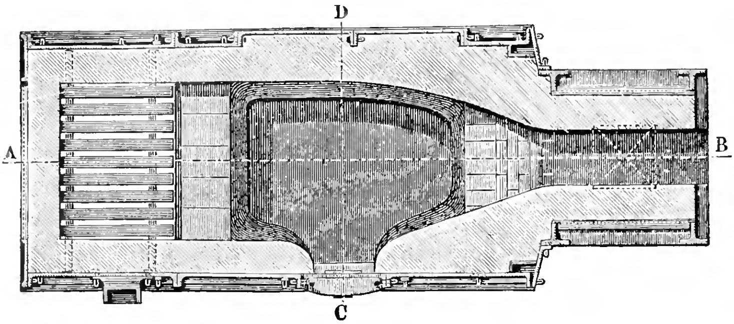

Fig. 25.—Plan of a Modern Puddling-Furnace.

and, coming up blandly smiling, with the remark "We always told you so," forthwith proceeded to foolishly praise that which they had more foolishly condemned.

The rapid increase of the manufacture of iron in consequence of the introduction of the puddling process naturally called for a

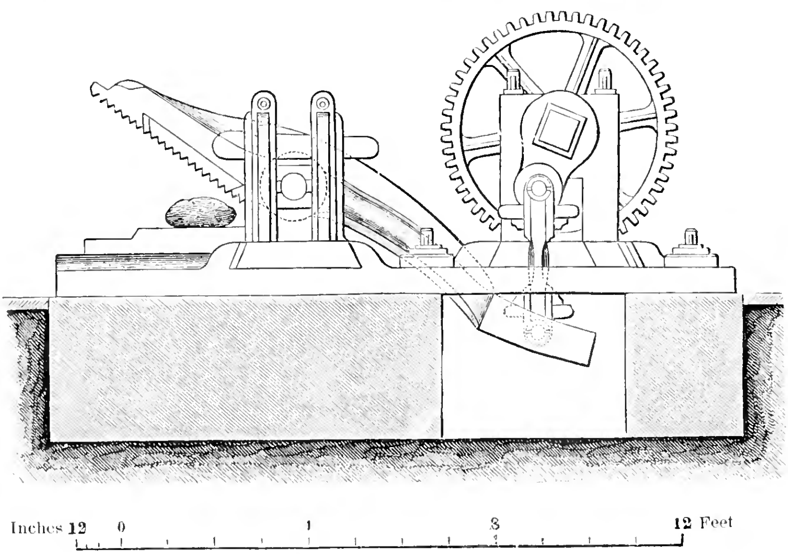

Fig. 26.—The Alligator Squeezer.

more expeditious method than the blows of a "trip-hammer" for expelling the cinder from the "puddle-balls" and forming them into "blooms"; and this necessity resulted in the invention of the "alligator squeezer," which consisted (as shown in Fig. 26) of a lever whose long arm was operated by a crank, the short arm being provided on its under side with a number of angular corrugations, so that it is somewhat suggestive of the jaw and teeth of an alligator. The "ball" from the puddling-furnace was placed between the upper and lower jaws of this squeezer, and the workmen turned it with tongs at each upward movement of the upper jaw (always moving it toward the fulcrum of the lever), thus causing the ball to be forcibly squeezed by each downward movement; and when the operation was completed the most of the liquid cinder had been expelled from the ball, which had assumed the form of a bloom.

Although this apparatus was of sufficient capacity for shingling a very much larger product than the trip-hammer which it displaced, yet it required the assistance of a workman, or "shingler," as he was called; and, as the number of puddling-furnaces increased in the mills, it soon became evident that more rapid and purely automatic machinery for shingling puddle-balls was desirable. This want was supplied by the inventive genius of Henry Burden, of Troy, N. Y., who in 1840 invented the "rotary squeezer." Fig. 27 is an elevation of the original form of this machine, and Fig. 28 is a horizontal section of Fig. 27 on line A B. The construction consisted substantially of a heavy cast-iron casing or "scroll," *a a* (Fig. 28), firmly attached to four surrounding columns, which stood upon a heavy bed-plate and also sustained a massive casting which formed the upper support and bearing of a vertical shaft to which the heavy cast-iron drum *b* (Fig. 28) was firmly attached; below the bed-plate is seen (in Fig. 27) the gearing for giving motion to the shaft and drum.

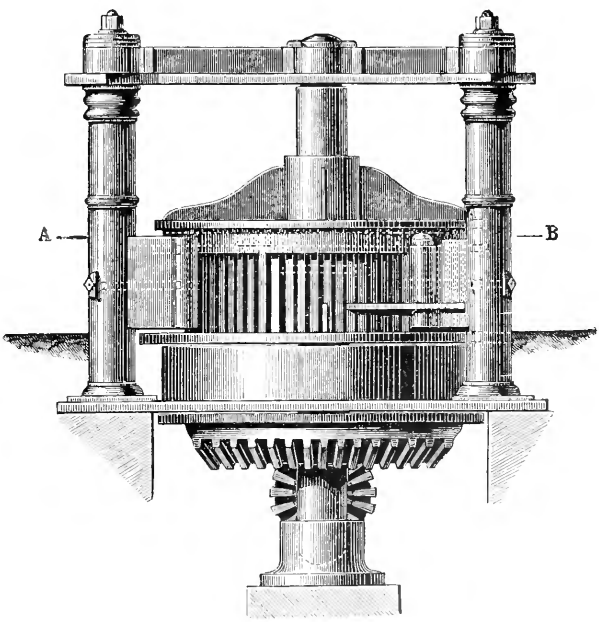

Fig. 27.—The Rotary Squeezer.

The "puddle-ball" was thrown into the machine at the place indicated by the arrow (Fig. 28), and, as the drum *b* revolved rapidly to the left, the ball was drawn in between it and the scroll, the teeth on each preventing its slipping; and, as it was carried around by the movement of the drum, the constantly narrowing space caused the ball to be subjected to great pressure, which expelled the liquid cinder and at the same time forced the ball to assume before it was ejected from the machine the form of a cylindrical bloom. In order that the squeezer should accommodate balls of considerable variation in weight, and at the same time exert a powerful end-pressure or "upsetting" during the operation of shingling, a very heavy ring of cast iron (shown in the plane A B, Fig. 27) was made to rest upon the upper end of the mass of metal as it passed through the machine; this ring was kept in position horizontally and guided in its movement vertically by the upper part of the spindle of the drum *b*. The finished "bloom" was discharged from the "squeezer" at the right-hand side of the opening in the "scroll" through which the "ball" originally entered, and such was the rapidity of the operation that the "bloom" retained sufficient heat at its close to permit of its being passed directly through the "rolls" and rolled into "billets" or "muck-bars" without reheating.

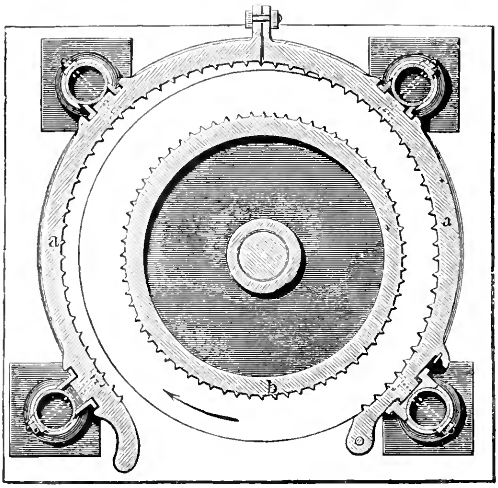

Fig. 28.—Plan of the Rotary Squeezer.

The modern form of the above-described machine differs somewhat from that shown in the illustrations in the arrangement of its driving-gear, but the general principles embodied in the original construction are still retained. Large numbers of "Burden Rotary Squeezers" are in use in the rolling-mills of the world, and it may fairly take rank as one of the most important improvements in the manufacture of iron that have had their origin in America.

Coincident with the improvements in apparatus and methods for producing wrought iron, the general advancement of all the arts, and especially those relating to the manufacture of machinery, created a demand for forgings of a size impossible of execution by the ancient trip and helve hammers; and as a means of supplying this need for uncommonly heavy forgings, the manufacture of the "Nasmyth direct-acting steam hammer" was commenced in the year 1843, by Messrs. Merrick & Towne, at the Southwark Foundry, Philadelphia, Pa. The "Nasmyth hammer," as at first constructed at this establishment, is represented by Fig. 29, in which A A A are the two upright frames of cast iron, which supported a lintel, C, that sustained the steam-cylin-

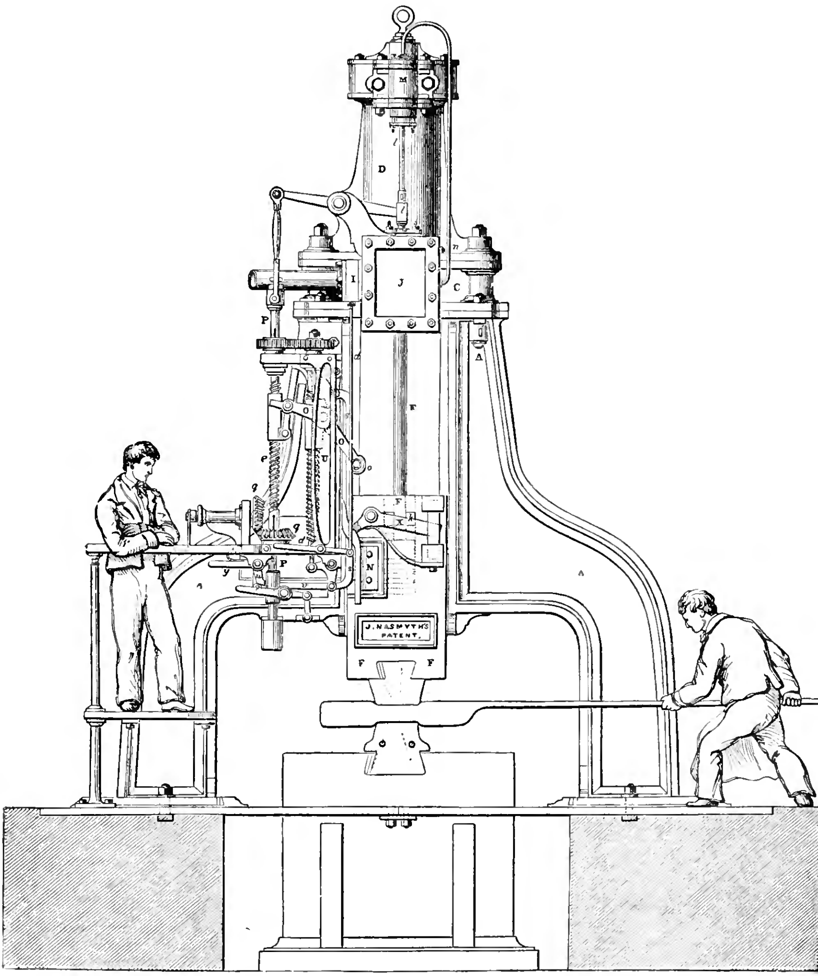

FIG. 29.—THE NASMYTH STEAM HAMMER.

der, D, and its steam-chest, J. The piston-rod, E, was secured at its lower end to the "hammer-block," F F F, which was free to move vertically between, and was guided by, the upright frames, A A A. The valve-gear is shown on the left-hand frame, A, which actuated the valve in the steam-chest, J. The intensity or working force of the blow delivered to the work upon the anvil

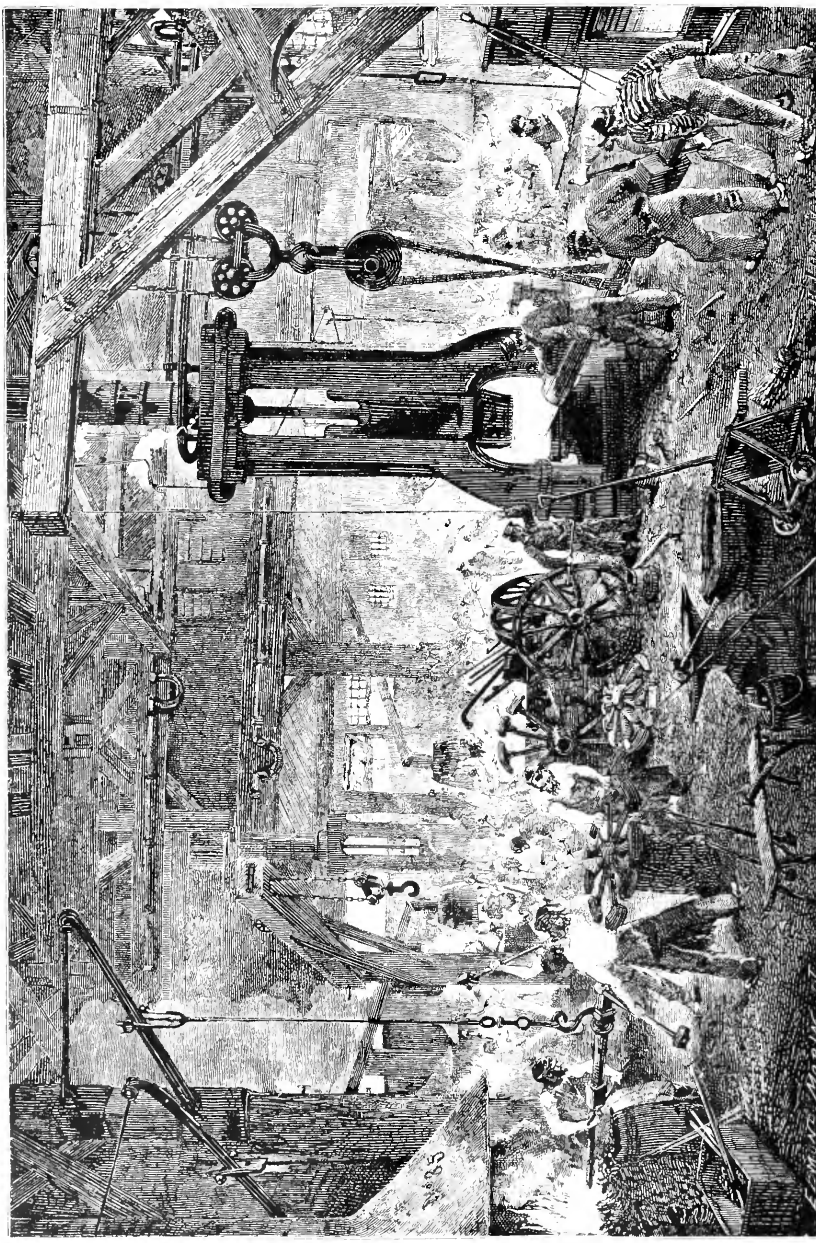

Fig. 30.—A Modern Forge.

varied with the height through which the "hammer-block" was allowed to fall, and this height could be regulated within the limits of the full stroke of the hammer by means of the valve-gear. As soon as the blow had been delivered, the mechanism for effecting the upward movement of the hammer-block came into action. This consisted of a heavy lever, X, which had its fulcrum on the hammer-block, F F. The shorter arm of this lever rested in contact with a vertical bar connected with the valve-gear, P, in such a way that at whatever point of its length the bar chanced to receive a side pressure from the short arm of the lever, X, it caused the admission of steam to the lower end of the cylinder, D, thus causing the "hammer-block" to make its upward stroke. This occurred automatically the instant after the delivery of the blow; the inertia of the weighted end of the lever not being overcome, it moved downward after the "hammer-block" came to rest, and forced its short arm against the vertical bar in the manner described. Such, in brief, were the construction and operation of the first steam hammer built in America, and placed by its builders in the smith's shop of their Southwark Foundry, at Philadelphia, where (Mr. J. Vaughn Merrick writes me) it was "continuously employed till after the sale of the works in 1871."

The original invention of Nasmyth has undergone many changes, and since the expiration of his patents a multitude of modifications having for their object the improvement of its action or its adaptation to some particular variety of work have been brought forward; but they all involve the fundamental ideas of lifting a vertically guided heavy mass, or hammer-block, by the direct action of steam upon a piston with which it is connected, and letting it fall at pleasure upon the work in hand by cutting off the supply of steam and releasing that already beneath the piston; and this combination of ideas and methods originated with James Nasmyth, who, by his invention, augmented the strength of the arm of Vulcan and conferred new powers and possibilities upon the skill of man.

The appearance of a modern forge and all its Vulcanian activities is well represented by Fig. 30, which to an experienced eye presents what may be called a scene of well-regulated confusion, in which, amid smoke and flame, coal and iron, the hissing of steam, beating of sledges, ringing of anvils, and the scorching glare of white-hot metal, the stalwart, half-naked sons of Vulcan strain and sweat at their appointed tasks, while the solid earth for miles around quakes under the ponderous blows of the Cyclopean hammer * that

> . . . upheaves its mighty arm
> While on the anvil turns the glowing mass—

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* This is no exaggeration, as it has been authoritatively stated that the blows of the steam hammers in Woolwich Arsenal have been felt at Greenwich Observatory, about two miles distant.

and all make up a picture suggestive rather of the Inferno* or the wars of thunderbolt and tempest than an exemplification of the most important of the arts of peace.

[*To be continued.*]

STAR-STREAMS AND NEBULÆ.

By GARRETT P. SERVISS.

IT is wonderful what a mass of evidence confirmatory of the nebular hypothesis in its broadest sense has been accumulated within the past few years. Most of this new testimony in favor of an old theory has been furnished by Astronomical Photography, that giant that sees the invisible, which has recently risen to the aid of astronomers with the startling suddenness and unexpectedness of the Arab fisherman's afrite escaping from the despised bottle. Perhaps the most notable of these celestial photographs, in the direct light that it throws upon the nebular hypothesis, is Mr. Roberts's already famous picture of the Andromeda nebula. Nobody can look upon the vast nebulous spirals that this photograph reveals, surrounding a great central condensation, and showing here and there a brighter knot where a satellite of the huge focal mass is in process of formation, without feeling that Laplace and Kant were not very far astray in their guess as to the mode of formation of the solar system.

But, although stars in abundance are scattered over and around the Andromeda nebula, there is little in their appearance to suggest a connection between them and the nebula. It is different with the nebulæ in the Pleiades and in Orion. In the wonderful photographs of the Pleiades by the Henry brothers of Paris one not only sees masses of nebulous matter clinging, so to speak, to some of the more conspicuous stars, but in one place a long, straight, narrow strip of nebula has stars dotted along its whole length, like diamonds strung upon a ribbon. It becomes more difficult to resist the conclusion that in this strange nebulous streak, with its starry file, we possess an indication of the mode

* I am reminded of a stalwart iron-master who formerly owned a forge in New England, and whose ideas of futurity, apparently, were not perfectly definite—at any rate, he was disposed to be somewhat inquisitive in his way in regard thereto. Whenever he could tempt a clergyman to visit his forge, he would place him immediately in front of the largest furnace, and, as the attendant on a signal raised the door, revealing a temperature within that Nebuchadnezzar's furnace could not have surpassed, he would howl in the ear of the scorched and thoroughly frightened preacher the inquiry, "Is HELL any hotter than *that?*" It has not been recorded that he ever obtained any positive information in answer to this question, the circumstances of which doubtless afforded food for thought to the parties to whom it was put.

of origin of the many curious streams and chains of stars with which the heavens abound, when we look at another amazing revelation of celestial photography. I refer to Prof. Pickering's photograph of Orion, taken with a portrait-lens from a mountain in southern California.

In this photograph a tremendous spiral nebula is revealed, covering a space on the sky fifteen degrees in diameter, and embracing the whole of the constellation with the exception of the head and shoulders and the upraised arms of the imaginary giant. The well-known nebula in the Sword, the three bright stars in the Belt, the brilliant first-magnitude star Rigel, together with its less splendid neighbor Beta of Eridanus, and Kappa Orionis, forming the lower left-hand corner of the great quadrilateral of Orion—are all included within the boundaries of this vast nebula. The nebula in the Sword is seen to be only an exceptionally bright condensation in the nebulous system surrounding it.

But for our purposes the thing to be particularly noticed is the arrangement of the stars within the nebula. Any one who has viewed Orion with a powerful opera or field glass must have been struck with the curious marshaling of many of the smaller stars. This is particularly noticeable around the Belt, where the star Epsilon, itself long known to be enmeshed in a faint nebula, is environed with a garland of little stars, which, defiling in a beautiful double curve, finally stop near Delta, the next star above in the Belt. But, indeed, one does not need a glass in order to perceive similar rows of stars in Orion. The most conspicuous of these, after the three stars in the Belt themselves, are those that outline the giant's left arm and the lion's skin that he is supposed to bear upon it. Another row, not so striking, is, however, more interesting just at this point, because it follows the curve of the great outer spiral of the newly discovered nebula. This file of stars really begins below the Belt at Eta, and, curving round between the Belt and Gamma or Bellatrix in the left shoulder, includes the stars 27, 22, ψ^1, ψ^2, 33, 38, and ω, besides others too faint to be visible to the unassisted eye. The connection between these stars and the nebula seems too evident to be doubted. The spiral form of the latter furnishes an explanation

STAR GARLAND IN THE BELT OF ORION.

of the geometrical arrangement of the former. So with the chain of telescopic stars described above as winding around the bright stars in the Belt—the nebular forms account for the configuration of the stars.

In the cut of Orion's Belt, above, an attempt has been made to represent the appearance of the assemblage of small stars around Epsilon, the center star of the Belt. All the stars there shown can not be seen with an ordinary opera-glass, but a strong field-glass will reveal them and many more besides. In fact, with a powerful glass the complication of curving star-lines becomes rather confusing to one attempting to draw them, and the cut must be regarded rather as an "impressionist" picture than as one showing every star accurately in its place and of precisely the right magnitude. Still, it will be found an approximately correct representation. The reader should bear in mind the fact that the star Epsilon, the center of this remarkable sidereal array, has long been known to be surrounded by a strong nebulosity, and that in the photograph referred to this spot appears as one of the principal foci of the great spiral nebula. These considerations naturally lead to the conclusion (which has also been reached upon other grounds so far as the larger stars are concerned) that Epsilon and the other leading stars of Orion, with the exception of Betelgeuse, which lies beyond the boundaries of the nebula, are at practically the same distance from us as the small stars surrounding them, all being members of one system.

There are many such star-streams to be found in the sky where as yet no related nebulæ have been discovered. But one can hardly doubt, in view of the evidence which the photographs we have referred to furnish, that the forms of the streams are derived from the pre-existing forms of the parent nebulæ. In many cases, of course, the process of nebular condensation has been finished, and we can never expect to discover any evidence of the nebula having once existed beyond the peculiar configuration of the stars to which it gave birth. In other cases, as in this of Orion, photography may yet reveal to us the existence of faint nebulous spirals still connected with the star-groups. Prof. Holden's discovery of a starry ring connected with the celebrated ring nebula in Lyra is in direct accord with the revelations of photography in this respect. Another interesting example is furnished by Mr. W. F. Denning's discovery last September of a small nebula which is completely encircled by a ring of stars. It is impossible, when looking at Mr. Denning's sketch of this curious object in The Observatory, to think that the stars and the nebula there shown do not belong to a single system.

Among the most striking examples of curved or spiral stellar arrangement are the circlet of small stars surrounding Delta

Canis Majoris and the exceedingly beautiful star-curves in the neighborhood of Alpha Persei, both of which are figured in my Astronomy with an Opera-glass. No one can survey the heavens with any kind of an optical instrument for half an hour without discovering many similar instances. If it should ever be demonstrated that the individuals composing these star-rows have all an identical parallax, or, in other words, are all at the same distance from us, so much additional strength would be given to the argument that they owe their origin to a nebula which resembled in shape the figure that they mark out. But the inherent probability that the stars concerned in such cases really do have practically the same parallax is so great that actual measurement could hardly make it stronger.

Looking at the matter still more broadly, it is clear that the Milky Way itself may be regarded as the starry residuum of a far grander nebula even than that of Orion, which once completely encircled our heavens; while the origin of such stellar streams as we behold in Eridanus, Pisces, and other constellations having their stars comparatively widely separated and few in number, may be referred to smaller nebulous masses once scattered over the region of space included within and extending on each side of the plane of the galactic circle.

THE ARYAN QUESTION AND PREHISTORIC MAN.

By Prof. T. H. HUXLEY.

THE rapid increase of natural knowledge, which is the chief characteristic of our age, is effected in various ways. The main army of science moves to the conquest of new worlds slowly and surely, nor ever cedes an inch of the territory gained. But the advance is covered and facilitated by the ceaseless activity of clouds of light troops provided with a weapon—always efficient, if not always an arm of precision—the scientific imagination. It is the business of these *enfants perdus* of science to make raids into the realm of ignorance wherever they see, or think they see, a chance; and cheerfully to accept defeat, or it may be annihilation, as the reward of error. Unfortunately, the public, which watches the progress of the campaign, too often mistakes a dashing incursion of the Uhlans for a forward movement of the main body; fondly imagining that the strategic movement to the rear, which occasionally follows, indicates a battle lost by science. And it must be confessed that the error is too often justified by the effects of the irrepressible tendency which men of science share with all other sorts of men known to me, to be impatient of that most wholesome state of mind—suspended judgment; to assume the objective truth of speculations which, from the nature of the evidence in their favor, can have no claim to be more than working hypotheses.

The history of the "Aryan question" affords a striking illustration of these general remarks.

About a century ago, Sir William Jones pointed out the close alliance of the chief European languages with Sanskrit and its derivative dialects now spoken in India. Brilliant and laborious philologists, in long succession, enlarged and strengthened this position until the truth that Sanskrit, Zend, Armenian, Greek, Latin, Lithuanian, Slavonian, German, Celtic, and so on, stand to one another in the relation of descendants from a common stock became firmly established, and thenceforward formed part of the permanent acquisitions of science. Moreover, the term "Aryan" is very generally, if not universally, accepted as a name for the group of languages thus allied. Hence, when one speaks of "Aryan languages," no hypothetical assumptions are involved. It is a matter of fact that such languages exist, that they present certain substantial and formal relations, and that convention sanctions the name applied to them. But the close connection of these widely differentiated languages remains altogether inexplicable, unless it is admitted that they are modifications of an original relatively undifferentiated tongue; just as the intimate affinities of the Romance languages—French, Italian, Spanish, and the rest—would be incomprehensible if there were no Latin. The original or "primitive Aryan" tongue, thus postulated, unfortunately no longer exists. It is a hypothetical entity, which corresponds with the "primitive stock" of generic and higher groups among plants and animals; and the acknowledgment of its former existence, and of the process of evolution which has brought about the present state of things philological, is forced upon us by deductive reasoning of similar cogency to that employed about things biological.

Thus, the former existence of a body of relatively uniform dialects, which may be called primitive Aryan, may be added to the stock of definitely acquired truths. But it is obvious that, in the absence of writing or of phonographs, the existence of a language implies that of speakers. If there were primitive Aryan dialects, there must have been primitive Aryan people who used them; and these people must have resided somewhere or other on the earth's surface. Hence philology, without stepping beyond its legitimate bounds and keeping speculation within the limits of bare necessity, arrives, not only at the conceptions of Aryan languages and of a primitive Aryan language, but of a primitive Aryan people and of a primitive Aryan home, or country occupied by them.

But where was this home of the Aryans? When the labors of modern philologists began, Sanskrit was the most archaic of all the Aryan languages known to them. It appeared to present the qualifications required in the parental or primitive Aryan. Brilliant Uhlans made a charge at this opening. The scientific imagination seated the primitive Aryans in the valley of the Ganges; and showed, as in a vision, the successive columns, guided by enterprising Brahmans, which set out thence to people the regions of the Western world with Greeks and Celts and Germans. But the progress of philology itself sufficed to show that this Balaclava charge, however magnificent, was not profitable warfare. The internal evidence of the Vedas proved that their composers had not reached the Ganges. On the other hand, the comparison of Zend with Sanskrit left no alternative open to the assumption that these languages were modifications of an original Indo-Iranian tongue, spoken by a people of whom the Aryans of India and those of Persia were offshoots, and who could therefore be hardly lodged elsewhere than on the frontiers of both Persia and India—that is to say, somewhere in the region which is at present known under the names of Turkistan, Afghanistan, and Kafiristan. Thus far, it can hardly be doubted that we are well within the ground of which science has taken enduring possession. But the Uhlans were not content to remain within the lines of this surely-won position. For some reason, which is not quite clear to me, they thought fit to restrict the home of the primitive Aryans to a particular part of the region in question; to lodge them amid the bleak heights of the long range of the Hindoo Koosh and on the inhospitable plateau of Pamir. From their hives in these secluded valleys and wind-swept wastes, successive swarms of Celts and Greco-Latins, Teutons and Slavs, were thrown off to settle, after long wanderings, in distant Europe. The Hindoo-Koosh-Pamir theory, once enunciated, gradually hardened into a sort of dogma; and there have not been wanting theorists who laid down the routes of the successive bands of emigrants with as much confidence as if they had access to the records of the office of a primitive Aryan quartermaster-general. It is really singular to observe the deference which has been shown, and is yet sometimes shown, to a speculation which can, at best, claim to be regarded as nothing better than a somewhat risky working hypothesis.

Forty years ago, the credit of the Hindoo-Koosh-Pamir theory had risen almost to that of an axiom. The first person to instill doubt of its value into my mind was the late Robert Gordon Latham, a man of great learning and singular originality, whose attacks upon the Hindoo-Kooshite doctrine could scarcely have failed as completely as they did, if his great powers had been bestowed upon making his books not only worthy of being read, but readable. The impression left upon my mind, at that time, by various conversations about the "Sarmatian hypothesis," which my friend wished to subsitute for the Hindoo-Koosh-Pamir speculation, was that the one and the other rested pretty much upon a like foundation of guess-work. That there was no sufficient reason for planting the primitive Aryans in the Hindoo Koosh, or in Pamir, seemed plain enough; but that there was little better ground, on the evidence then adduced, for settling them in the region at present occupied by western Russia, or Podolia, appeared to me to be not less plain. The most I thought Latham proved was, that the Aryan people of Indo-Iranian speech were just as likely to have come from Europe, as the Aryan people of Greek, or Teutonic, or Celtic speech from Asia. Of late years, Latham's views, so long neglected, or mentioned merely as an example of insular eccentricity, have been taken up and advocated with much ability in Germany as well as in this country—principally by philologists. Indeed, the glory of Hindoo-Koosh-Pamir seems altogether to have departed. Prof. Max Müller, to whom Aryan philology owes so much, will not say more now, than that he holds by the conviction that the seat of the primitive Aryans was "somewhere in Asia." Dr. Schrader sums up in favor of European Russia; while Herr Penka would have us transplant the home of the primitive Aryans from Pamir in the far East to the Scandinavian Peninsula in the far West.

I must refer those who desire to acquaint themselves with the philological arguments on which these conclusions are based to the recently published works of Dr. Schrader and Canon Taylor;* and to Penka's Die Herkunft der Arier, which, in spite of the strong spice of the Uhlan which runs through it, I have found extremely well worth study. I do not pretend to be able to look at the Aryan question under any but the biological aspect; to which I now turn.

Any biologist who studies the history of the Aryan question, and, taking the philological facts on trust, regards it exclusively from the point of view of anthropology, will observe that, very early, the purely biological conception of "race" illegitimately mixed itself up with the ideas derived from pure philology. It is quite proper to speak of Aryan "people," because, as we have seen, the existence of the language implies that of a people who speak it; it might be equally permissible to call Latin people all those who speak Romance dialects. But, just as the application of the term Latin "race" to the divers people who speak Romance languages, at the present day, is none the less absurd be-

* Schrader, Prehistoric Antiquities of the Aryan Peoples. Translated by F. B. Jevons, M. A., 1890. Taylor, The Origin of the Aryans, 1890.

cause it is common; so it is quite possible that it may be equally wrong to call the people who spoke the primitive Aryan dialects and inhabited the primitive home, the Aryan race. "Aryan" is properly a term of classification used in philology. "Race" is the name of a subdivision of one of those groups of living things which are called "species" in the technical language of zoölogy and botany; and the term connotes the possession of characters distinct from those of the other members of the species, which have a strong tendency to appear in the progeny of all members of the races. Such race-characters may be either bodily or mental, though in practice, the latter, as less easy of observation and definition, can rarely be taken into account. Language is rooted half in the bodily and half in the mental nature of man. The vocal sounds which form the raw materials of language could not be produced without a peculiar conformation of the organs of speech; the enunciation of duly accented syllables would be impossible without the nicest co-ordination of the action of the muscles which move these organs; and such co-ordination depends on the mechanism of certain portions of the nervous system. It is therefore conceivable that the structure of this highly complex speaking apparatus should determine a man's linguistic potentiality; that is to say, should enable him to use a language of one class and not another. It is further conceivable that a particular linguistic potentiality should be inherited and become as good a race-mark as any other. As a matter of fact, it is not proved that the linguistic potentialities of all men are the same. It is affirmed, for example, that, in the United States, the enunciation and the timbre of the voice of an American-born negro, however thoroughly he may have learned English, can be readily distinguished from that of a white man. But, even admitting that differences may obtain among the various races of men, to this extent, I do not think that there is any good ground for the supposition that an infant of any race would be unable to learn, and to use with ease, the language of any other race of men among whom it might be brought up. History abundantly proves the transmission of languages from some races to others; and there is no evidence, that I know of, to show that any race is incapable of substituting a foreign idiom for its native tongue.

From these considerations it follows that community of language is no proof of unity of race, is not even presumptive evidence of racial identity.* All that it does prove is that, at some

* Canon Taylor (Origin of the Aryans, p. 31) states that "Cuno . . . was the first to insist on what is now looked on as an axiom in ethnology—that race is not coextensive with language," in a work published in 1871. I may be permitted to quote a passage from a lecture delivered on the 9th of January, 1870, which brought me into a great deal of trouble. "Physical, mental, and moral peculiarities go with blood and not with language.

time or other, free and prolonged intercourse has taken place between the speakers of the same language. Philology, therefore, while it may have a perfect right to postulate the existence of a primitive Aryan "people," has no business to substitute "race" for "people." The speakers of primitive Aryan may have been a mixture of two or more races, just as are the speakers of English and of French at the present time.

The older philological ethnologists felt the difficulty which arose out of their identification of linguistic with racial affinity, but were not dismayed by it. Strong in the prestige of their great discovery of the unity of the Aryan tongues, they were quite prepared to make the philological and the biological categories fit, by the exercise of a little pressure on that about which they knew less. And their judgment was often unconsciously warped by strong monogenistic proclivities, which at bottom, however respectable and philanthropic their origin, had nothing to do with science. So the patent fact that men of Aryan speech presented widely diverse racial characters was explained away by maintaining that the physical differentiation was post-Aryan; to put it broadly, that the Aryans in Hindoo-Koosh-Pamir were truly of one race; but that, while one colony, subjected to the sweltering heat of the Gangetic plains, had fined down and darkened into the Bengalee, another had bleached and shot up, under the cool and misty skies of the north, into the semblance of Pomeranian grenadiers; or of blue-eyed, fair-skinned, six-foot Scotch Highlanders. I do not know that any of the Uhlans who fought so vigorously under this flag are left now. I doubt if any one is prepared to say that he believes that the influence of external conditions, alone, accounts for the wide physical differences between Englishmen and Bengalese. So far as India is concerned, the internal evidence of the old literature sufficiently proves that the Aryan invaders were "white" men. It is hardly to be doubted that they intermixed with the dark Dravidian aborigines; and that the high-caste Hindoos are what they are in virtue of the Aryan blood which they have inherited,* and of the selective influence of their surroundings operating on the mixture.

In the United States the negroes have spoken English for generations; but no one on that ground would call them Englishmen, or expect them to differ physically, mentally, or morally from other negroes." (Pall Mall Gazette, January 10, 1870.) But the "axiom in ethnology" had been implied, if not enunciated, before my time; for example, by Ecker in 1865.

* I am unable to discover good grounds for the severity of the criticism, in the name of "the anthropologists," with which Prof. Max Müller's assertion that the same blood runs in the veins of English soldiers "as in the veins of the dark Bengalese," and that there is "a legitimate relationship between Hindoo, Greek, and Teuton," has been visited. So far as I know anything about anthropology, I should say that these statements may be correct literally, and probably are so substantially. I do not know of any good reason for

The assumption that, as there must have been a primitive Aryan people, in the philological sense, so that people must have constituted a race in the biological sense, is pretty generally made in modern discussions of the Aryan problem. But whether the men of the primitive Aryan race were blonds or brunets, whether they had long or round heads, were tall or were short, are hotly debated questions, into the discussion of which considerations quite foreign to science are sometimes imported. The combination of swarthiness with stature above the average and a long skull, confer upon me the serene impartiality of a mongrel; and, having given this pledge of fair dealing, I proceed to state the case for the hypothesis I am inclined to adopt. In doing so, I am aware that I deliberately take the shilling of the recruiting sergeant of the Light Brigade, and I warn all and sundry that such is the case.

Looking at the discussions which have taken place from a purely anthropological point of view, the first point which has struck me is that the problem is far more complicated and difficult than many of the disputants appear to imagine; and the second, that the data upon which we have to go are grievously insufficient in extent and in precision. Our historical records cover such an infinitesimally small extent of the past life of humanity, that we obtain little help from them. Even so late as 1500 B. C., northern Eurasia lies in historical darkness, except for such glimmer of light as may be thrown here and there by the literature of Egypt and of Babylonia. Yet, at that time, it is probable that Sanskrit, Zend, and Greek, to say nothing of other Aryan tongues, had long been differentiated from primitive Aryan. Even a thousand years later, little enough accurate information is to be had about the racial characters of the European and Asiatic tribes known to the Greeks. We are thrown upon such resources as archæology and human paleontology have to offer, and, notwithstanding the remarkable progress made of late years, they are still meager. Nevertheless, it strikes me that, from the purely anthropological side, there is a good deal to be said in favor of the two propositions maintained by the new school of philologists: first, that the people who spoke "primitive Aryan" were a distinct and well-marked race of mankind; and, secondly, that the area of the distribution of this race, in primeval times, lay in Europe, rather than in Asia.

For the last two thousand years, at least, the southern half of Scandinavia and the opposite or southern shores of the Baltic have been occupied by a race of mankind possessed of very definite

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the physical differences between a high-caste Hindoo and a Dravidian, except the Aryan blood in the veins of the former; and the strength of the infusion is probably quite as great in some Hindoos as in some English soldiers.

characters. Typical specimens have tall and massive frames, fair complexions, blue eyes, and yellow or reddish hair—that is to say, they are pronounced blonds. Their skulls are long, in the sense that the breadth is usually less, often much less, than four fifths of the length, and they are usually tolerably high. But in this last respect they vary. Men of this blond, long-headed race abound from eastern Prussia to northern Belgium; they are met with in northern France and are common in some parts of our own islands. The people of Teutonic speech, Goths, Saxons, Alemanni, and Franks, who poured forth out of the regions bordering the North Sea and the Baltic, to the destruction of the Roman Empire, were men of this race; and the accounts of the ancient historians of the incursions of the Gauls into Italy and Greece, between the fifth and the second centuries B. C., leave little doubt that their hordes were largely, if not wholly, composed of similar men. The contents of numerous interments in southern Scandinavia prove that, as far back as archæology takes us into the so-called Neolithic age, the great majority of the inhabitants had the same stature and cranial peculiarities as at present, though their bony fabric bears marks of somewhat greater ruggedness and savagery. There is no evidence that the country was occupied by men before the advent of these tall, blond long-heads. But there is proof of the presence, along with the latter, of a small percentage of people with broad skulls—skulls, that is, the breadth of which is more, often very much more, than four fifths of the length.

At the present day, in whatever direction we travel inland from the continental area occupied by the blond long-heads, whether southwest, into central France; south, through the Walloon provinces of Belgium into eastern France; into Switzerland, south Germany, and the Tyrol; or southeast, into Poland and Russia; or north, into Finland and Lapland, broad-heads make their appearance, in force, among the long-heads. And, eventually, we find ourselves among people who are as regularly broad-headed as the Swedes and North Germans are long-headed. As a general rule, in France, Belgium, Switzerland, and south Germany, the increase in the proportion of broad skulls is accompanied by the appearance of a larger and larger proportion of men of brunet complexion and of a lower stature; until, in central France and thence eastward, through the Cevennes and the Alps of Dauphiny, Savoy, and Piedmont, to the western plains of north Italy, the *tall blond long-heads* * practically disappear, and are replaced by

* I may plead the precedent of the good English words "block-head" and "thick-head" for "broad-head" and "long-head," but I can not say that they are elegant. I might have employed the technical terms brachycephali and dolichocephali. But it can not be said that they are much more graceful; and, moreover, they are sometimes em-

short brunet broad-heads. The ordinary Savoyard may be described in terms the converse of those which apply to the ordinary Swede. He is short, swarthy, dark-eyed, dark-haired, and his skull is very broad. Between the two extreme types, the one seated on the shores of the North Sea and the Baltic, and the other on those of the Mediterranean, there are all sorts of intermediate forms, in which breadth of skull may be found in tall and in short blond men, and in tall brunet men.

There is much reason to believe that the brunet broad-heads, now met with in central France and in the west central European highlands, have inhabited the same region, not only throughout the historical period, but long before it commenced; and it is probable that their area of occupation was formerly more extensive. For, if we leave aside the comparatively late incursions of the Asiatic races, the center of eruption of the invaders of the southern moiety of Europe has been situated in the north and west. In the case of the Teutonic inroads upon the empire of Rome, it undoubtedly lay in the area now occupied by the blond long-heads; and, in that of the antecedent Gaulish invasions, the physical characters ascribed to the leading tribes point to the same conclusion. Whatever the causes which led to the breaking out of bounds of the blond long-heads, in mass, at particular epochs, the natural increase in numbers of a vigorous and fertile race must always have impelled them to press upon their neighbors, and thereby afford abundant occasions for intermixture. If, at any given prehistoric time, we suppose the lowlands verging on the Baltic and the North Sea to have been inhabited by pure blond long-heads, while the central highlands were occupied by pure brunet short-heads the two would certainly meet and intermix in course of time, in spite of the vast belt of dense forest which extended, almost uninterruptedly, from the Carpathians to the Ardennes; and the result would be such an irregular gradation of the one type into the other as we do, in fact, meet with.

On the southeast, east, and northeast, throughout what was once the kingdom of Poland, and in Finland, the preponderance of broad-heads goes along with a wide prevalence of blond complexion and of good stature. In the extreme north, on the other hand, marked broad-headedness is combined with low stature, swarthiness, and more or less strongly Mongolian features, in the

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ployed in senses different from that which I have given in the definition of broad-heads and long-heads. The *cephalic index* is a number which expresses the relation of the breadth to the length of a skull, taking the latter as 100. Therefore, "broad-heads" have the cephalic index above 80 and "long-heads" have it below 80. The physiological value of the difference is unknown; its morphological value depends upon the observed fact of the constancy of the occurrence of either long skulls or broad skulls among large bodies of mankind.

Lapps. And it is to be observed that this type prevails increasingly to the eastward, among the central Asiatic populations.

The population of the British Islands, at the present time, offers the two extremes of the tall blond and the short brunet types. The tall blond long-heads resemble those of the continent; but our short brunet race is long-headed. Brunet broad-heads, such as those met with in the central European highlands, do not exist among us. This absence of any considerable number of distinctly broad-headed people (say with the cephalic index above 81 or 82) in the modern population of the United Kingdom is the more remarkable, since the investigations of the late Dr. Thurnam, and others, proved the existence of a large proportion of, tall broad-heads among the people interred in British tumuli of the Neolithic age. It would seem that these broad-skulled immigrants have been absorbed by an older long-skulled population; just as, in south Germany, the long-headed Alemanni have been absorbed by the older broad-heads. The short brunet long-heads are not peculiar to our islands. On the contrary, they abound in western France and in Spain, while they predominate in Sardinia, Corsica, and south Italy, and, it may be, occupied a much larger area in ancient times.

Thus, in the area which has been under consideration, there are evidences of the existence of four races of men: (1) blond long-heads of tall stature, (2) brunet broad-heads of short stature, (3) Mongoloid brunet broad-heads of short stature, (4) brunet long-heads of short stature. The regions in which these races appear with least admixture are—(1) Scandinavia, north Germany, and parts of the British Islands; (2) central France, the central European highlands, and Piedmont; (3) arctic and eastern Europe, central Asia; (4) the western parts of the British Islands and of France; Spain, south Italy. And the inhabitants of the regions which lie between these foci present the intermediate gradations, such as short blond long-heads, and tall brunet short-heads and long-heads which might be expected to result from their intermixture. The evidence at present extant is consistent with the supposition that the blond long-heads, the brunet broad-heads, and the brunet long-heads have existed in Europe throughout historic times, and very far back into prehistoric times. There is no proof of any migration of Asiatics into Europe, west of the basin of the Dnieper, down to the time of Attila. On the contrary, the first great movements of the European population of which there is any conclusive evidence is that series of Gaulish invasions of the east and south, which ultimately extended from north Italy as far as Galatia in Asia Minor.

It is now time to consider the relations between the phenomena of racial distribution, as thus defined, and those of the distribution of languages. The blond long-heads of Europe speak, or have spoken, Lithuanian, Teutonic, or Celtic dialects, and they are not known to have ever used any but these Aryan languages. A large proportion of the brunet broad-heads once spoke the Ligurian and the Rhætic dialects, which are believed to have been non-Aryan. But, when the Romans made acquaintance with Transalpine Gaul, the inhabitants of that country between the Garonne and the Seine (Cæsar's *Celtica*) seem, at any rate for the most part, to have spoken Celtic dialects. The brunet long-heads of Spain and of France appear to have used a non-Aryan language, that Euskarian which still lives on the shores of the Bay of Biscay. In Britain there is no certain knowledge of their use of any but Celtic tongues. What they spoke in the Mediterranean islands and in south Italy does not appear.

The blond broad-heads of Poland and west Russia form part of a people who, when they first made their appearance in history, occupied the marshy plains imperfectly drained by the Vistula on the west, the Duna on the north, and the Dnieper and Bug on the south. They were known to their neighbors as Wends, and among themselves as Serbs and Slavs. The Slavonic languages spoken by these people are said to be most closely allied to that of the Lithuanians, who lay upon their northern border. The Slavs resemble the south Germans in the predominance of broad-heads among them, while stature and complexion vary from the, often tall, blonds who prevail in Poland and Great Russia to the, often short, brunets common elsewhere. There is certainly nothing in the history of the Slav people to interfere with the supposition that, from very early times, they have been a mixed race. For their country lies between that of the tall blond long-heads on the north, that of the short brunet broad-heads of the European type on the west, and that of the short brunet broad-heads of the Asiatic type on the east: and throughout their history they have either thrust themselves among their neighbors, or have been overrun and trampled down by them. Gauls and Goths have traversed their country, on their way to the east and south: Finno-Tataric people, on their way to the west, have not only done the like, but have held them in subjection for centuries. On the other hand, there have been times when their western frontier advanced beyond the Elbe; indeed, it is asserted that they have sent colonies to Holland and even as far as southern England. A large part of eastern Germany; Bohemia, Moravia, Hungary; the lower valley of the Danube and the Balkan Peninsula, have been largely or completely Slavonized; and the Slavonic rule and language, which once had trouble to hold their own in west Russia and Little Russia, have now extended their sway over all the Finno-Tataric populations of Great Russia; while they are advancing, among those of central Asia, up to the frontiers of India on the south and to the Pacific on the extreme east. Thus it is hardly possible that fewer than three races should have contributed to the formation of the Slavonic people; namely, the blond long-heads, the European brunet broad-heads, and the Asiatic brunet broad-heads. And, in the absence of evidence to the contrary, it is certainly permissible to suppose that it is the first race which has furnished the blond complexion and the stature observable in so many, especially of the northern Slavs, and that the brunet complexion and the broad skulls must be attributed to the other two. But, if that supposition is permissible, then the Aryan form and substance of the Slavonic languages may also be fairly supposed to have proceeded from the blond long-heads. They could not have come from the Asiatic brunet broad-heads, who all speak non-Aryan languages; and the presumption is against their coming from the brunet broad-heads of the central European highlands, among whom an apparently non-Aryan language was largely spoken, even in historical times.

In the same way, the tall blond tribes among the Finns may be accounted for as the product of admixture. The great majority of the Finno-Tataric people are brunet broad-heads of the Asiatic type. But that the Finns proper have long been in contact with the Aryans is evidenced by the many words borrowed from Aryan which their language contains. Hence there has been abundant opportunity for the mixture of races, and for the transference to some of the Finns of more or fewer of the physical characters of the Aryans, and *vice versa*. On any hypothesis, the frontier between Aryan and Finno-Tataric people must have extended across west-central Asia for a very long period; and at any point of this frontier, it has been possible that mixed races of blond Finns or of brunet Aryans should be formed.

So much for the European people who now speak Celtic, or Teutonic, or Slavonian, or Lithuanian tongues; or who are known to have spoken them before the supersession of so many of the early native dialects by the Romance modifications of the language of Rome. With respect to the original speakers of Greek and Latin, the unraveling of the tangled ethnology of the Balkan Peninsula and the ordering of the chaos of that of Italy are enterprises upon which I do not propose to enter. In regard to the first, however, there are a few tolerably satisfactory data. The ancient Thracians were proverbially blue-eyed and fair-haired. Tall blonds were common among the ancient Greeks, who were a long-headed people; and the Sphakiots of Crete, probably the purest repre. sentatives of the old Hellenes in existence, are tall and blond-But considering that Greek colonization was taking place on a great scale in the eighth century B. C., and that, centuries earlier and later, the restless Hellene had been fighting, trading, plundering, and kidnapping, on both sides of the Ægean, and perhaps as far as the shores of Syria and of Egypt, it is probable that, even at the dawn of history, the maritime Greeks were a very mixed race. On the other hand, the Dorians may well have preserved the original type; and their famous migration may be the earliest known example of those movements of the Aryan race which were, in later times, to change the face of Europe. Analogy perhaps justifies a guess that those ethnological shadows, the Pelasgi, may have been an earlier mixed population, like that of western Gaul and of Britain before the Teutonic invasion. At any rate, the tall blond long-heads are so well represented in the oldest history of the Balkan Peninsula that they may be credited with the Aryan languages spoken there. And it may be that the tradition which peopled Phrygia with Thracians represents a real movement of the Aryan race into Asia Minor, such as that which in after-years carried the Gauls thither.

The difficulties in the way of a probable identification of the people among whom the various dialects of the Latin group developed themselves, with any race traceable in Italy in historical times, are very great. In addition to the Italic "aborigines" northern Italy was peopled by Ligurian brunet broad-heads; with Gauls, probably, to a large extent, blond long-heads; with Illyrians, about whom nothing is known. Besides these, there were those perplexing people the Etruscans, who seem to have been, originally, brunet long-heads. South Italy and Sicily present a contingent of "Sikels," Phœnicians and Greeks; while over all, in comparatively modern times, follows a wash of Teutonic blood. The Latin dialects arose, no one knows how, among the tribes of central Italy, encompassed on all sides by people of the most various physical characters, who were gradually absorbed into the eternally widening maw of Rome, and there, by dint of using the same speech, became the first example of that wonderful ethnological hotch-potch miscalled the Latin race. The only trustworthy guide here is archæological investigation. A great advance will have been made when the race characters of the prehistoric people of the terremare (who are identified by Helbig* with the primitive Umbrians) become fully known.

I can not learn that the ancient literatures of India and of Persia give any definite information about the complexion of the Indo-Iranians, beyond conveying the impression that they were what we vaguely call white men. But it is important to note

* Die Italiker in der Poebene, 1879. See, for much valuable information respecting the races of the Balkan and Italic Peninsulæ, Zampa's essay, Vergleichende anthropologische Ethnographie von Apulien, Zeitschrift für Ethnologie, xviii, 1886.

that tall blond people make their appearance sporadically among the Tadjiks of Persia and of Turkistan; that the Siah-posh and Galtchas of the mountainous barrier between Turkistan and India are such; and that the same characters obtain largely among the Kurds on the western frontier of Persia at the present day. The Kurds and the Galtchas are generally broad-headed, the others are long-headed. These people and the ancient Alans thus form a series of stepping-stones between the blond Aryans of Europe and those of Asia, standing up amid the flood of Finno-Tataric people which has inundated the rest of the interval between the sources of the Dnieper and those of the Oxus. If only more was known about the Sarmatians and the Scythians of the oldest historians, it is not improbable, I think, that we should discover that, even in historical times, the area occupied by the blond long-heads of Aryan speech has been, at least temporarily, continuous from the shores of the North Sea to central Asia.

Suppose it to be admitted, as a fair working hypothesis, that the blond long-heads once extended without a break over this vast area, and that all the Aryan tongues have been developed out of their original speech, the question respecting the home of the race when the various families of Aryan speech were in the condition of inceptive dialects remains open. For all that, at first, appears to the contrary, it may have been in the West, or in the East, or anywhere between the two. In seeking for a solution of this obscure problem, it is an important preliminary to grasp the truth that the Aryan race must be much older than the primitive Aryan speech. It is not to be seriously imagined that the latter sprang suddenly into existence, by the act of a jealous Deity, apparently unaware of the strength of man's native tendency toward confusion of speech. But if all the diverse languages of men were not brought suddenly into existence, in order to frustrate the plans of the audacious bricklayers of the plain of Shinar; if this professedly historical statement is only another "type," and primitive Aryan, like all other languages, was built up by a secular process of development, the blond long-heads, among whom it grew into shape, must for ages have been, philologically speaking, non-Aryans, or perhaps one should say, "pro-Aryans." I suppose it may be safely assumed that Sanskrit and Zend and Greek were fully differentiated in the year 1500 B. C. If so, how much further back must the existence of the primitive Aryan, from which these proceeded, be dated? And how much further yet, that real *juventus mundi* (so far as man is concerned) when primitive Aryan was in course of formation? And how much further still the differentiation of the nascent Aryan blond long-head race from the primitive stock of mankind?

If any one maintains that the blond long-headed people, among whom, by the hypothesis, the primitive Aryan language was generated, may have formed a separate race as far back as the Pleistocene epoch, when the first unquestionable records of man make their appearance, I do not see that he goes beyond possibility—though, of course, that is a very different thing from proving his case. But, if the blond long-heads are thus ancient, the problem of their primitive seat puts on an altogether new aspect. Speculation must take into account climatal and geographical conditions widely different from those which obtain in northern Eurasia at the present day. During much of the vast length of the Pleistocene period, it would seem that men could no more have lived either in Britain north of the Thames, or in Scandinavia, or in northern Germany, or in northern Russia, than they can live now in the interior of Greenland, seeing that the land was covered by a great ice sheet like that which at present shrouds the latter country. At that epoch, the blond long-heads can not reasonably be supposed to have occupied the regions in which we meet with them in the oldest times of which history has kept a record.

But even if we are content to assume a vastly less antiquity for the Aryan race; if we only make the assumption, for which there is considerable positive warranty, that it has existed in Europe ever since the end of the Pleistocene period—when the fauna and flora assumed approximately their present condition and the state of things called Recent by geologists set in—we have to reckon with a distribution of land and water, not only very different from that which at present obtains in northern Eurasia, but of such a nature that it can hardly fail to have exerted a great influence on the development and the distribution of the races of mankind.—*Nineteenth Century.*

[*To be continued.*]

THE STORAGE OF ELECTRICITY.

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THE problem how to save and store up the enormous amount of natural energy which is daily dissipated in producing natural phenomena has long occupied the attention of scientists. During the last fifteen years this attention has been especially directed toward electricity as an agent. This is, perhaps, because the majority of the really active investigators have been occupied in this department of science, or perhaps the popular superstitious credulity that electricity can be made to do anything, has, to a certain extent, taken possession of the scientific mind. At any rate, the result of experiments has been the development of the electrical storage batteries, or accumulators, as they are sometimes called.

The employment of these names for the apparatus is very unfortunate. They are the cause of the popular idea that electricity, which is considered as a subtle, indefinite, and intangible something, is stored up in them, as valuables are stored in a vault. The commercial current electricity can not, in large quantities, be stored and still preserve its character. It has but a flitting existence, and is no sooner produced than it dissipates itself and is converted into some other form of energy. It was because of this momentary existence that science had to wait so long for an accident to reveal to Galvani that such a thing could exist.

The energy which a current may at any instant be said to possess is immediately transformed into heat in the circuit, which will under certain conditions produce light; into chemical energy; into motion, which may or may not produce sound; or into magnetic and electrotonic conditions. The last may either be permanent or have the same evanescent existence as the original current.

When electricity is employed to charge a storage battery, only that part which is transformed into chemical energy is used. The rest is dissipated. The battery, then, instead of being a place where electricity is laid away, is a place where chemicals are left by the current, with the expectation that they will in turn produce a current when called upon. This may seem a fine distinction, but it is only apparently so. For instance, the current might be produced by a dynamo turned by Niagara water-power. The chemical left by it might be zinc deposited from a solution of zinc sulphate. This might be transported, preserved, bought and sold, and finally be employed by some physicist to produce another current. Were the electricity itself stored in its original form, then the imaginative reader can best tell what would become of it and how it must be handled.

To understand this transformation more clearly, and to obtain a clear idea of what goes on in a storage battery, one must first become acquainted with that part of electricity which treats of the phenomena resulting when a current of electricity passes through a liquid. This is called electrolysis, and the liquid through which a current can be made to pass is called an electrolyte.

If a current of electricity flows into a liquid solution of any metallic salt by means of a wire, and if, after traversing it, it flows out through another wire, then it will, by its passage, separate the salt into two parts and deposit the metal upon the latter wire.

If, for instance, the solution be one of silver cyanide, then silver will be deposited on the second wire. If a brass fork be connected with this wire and dipped in the solution, then it will receive a coating of silver by the process and will be silver-plated. Substitute a solution of nickel nitrate, and the article would become nickel-plated. By using copper sulphate we are enabled to cover the faces of types and cuts with a coating of copper, which increases their hardness and consequently their endurance.

This electrolytic action can be watched if a solution of tin chloride be used. Tin, instead of being deposited, like most other metals, in fine particles, comes out of the solution in quite large crystals. If the current of electricity be made to enter the solution through two wires, placed symmetrically on opposite sides of the wire through which it makes its exit, and the whole is performed in a vessel with glass sides, then, as the current passes, the crystals will appear, as if by magic, growing out around the central wire. This is but a modification of the "lead tree" which appears in many text-books on physics. The tin crystals, however, are much larger and more beautiful than those of lead.

The simplest storage battery, then, would seem to be one constructed of two copper plates suspended in a solution of some zinc salt. A current of electricity passed into this would deposit zinc upon one of the plates. After disconnecting the charging current, the battery of itself would give off a current until the zinc was redissolved. In fact, a modification of this form of storage battery has recently been placed upon the market. The question arises, however, whether it is cheaper to buy zinc sulphate and transform it by expensive horse-power into metallic zinc or to buy metallic zinc directly. Of course, in neither case is the zinc lost, for it can be recovered by chemical means from the solution. If solutions of zinc were abundant in nature and hence inexpensive, this style of storage battery would, undoubtedly, for economic reasons, prevail. Or, still further, if metallic zinc were inexpensive we would have no need of storage batteries at all, but could use primary batteries directly.

It might be well, right here, to define a primary battery. If any two different metals be dipped in an acidulated liquid, and if their external extremities be connected by a wire, a current of electricity will flow through the wire. Such a combination is called a primary battery. Under the same conditions the amount of electricity obtained depends upon the character of the metals. If nickel and iron were employed, a small amount of electricity would result. If, however, zinc be used in connection with either silver, gold, platinum, carbon, or copper, a large amount is obtained. The first three of the group are very expensive; hence, in most primary batteries, we find zinc combined with either carbon or copper, the differences between the various forms arising from difference in the liquids employed or in the shape of construction.

Furthermore, pieces of the same metal under different physical conditions, when combined with each other, will give a current. For instance, a piece of polished iron opposed to a rusty piece gives a current, and a plate of very rusty lead, if I may use the expression, combined with a piece of bright lead yields even more current than zinc and carbon. Unfortunately, lead does not rust sufficiently well to suit electricians, and other physical reasons prevent its being used in primary batteries.

It will thus be seen that a storage battery, when once charged, becomes nothing more or less than a primary battery. In the case before described, after charging, we have zinc and copper in a solution of zinc sulphate.

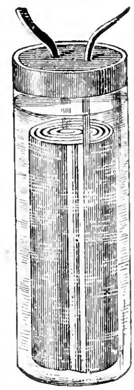
In describing the effects of electricity in passing through an electrolyte, we have assumed that the liquid contained a metal in solution. Suppose, now, that we take water, which has no metal in it, and subject it to the action of the current. The electricity can get no metal to deposit on the wire, where it passes out, and in consequence does the next best thing and leaves one of the components of the water—viz., hydrogen gas. The other component, oxygen, collects around the entrance wire. The English physicist Grove showed that, if these two wires, around which the gases had collected, were connected together, a current of electricity would flow the same as if there were two metals instead of two gases. Now, water is cheap, and if there were not some serious technical difficulties as regards efficiency, Grove's battery would be universally employed.

It was reserved, however, for M. Gaston Planté to construct the first practical secondary battery. He considered the following points in its construction: Water is cheap; water, when subjected to the electric current, gives off oxygen and hydrogen; rusty lead, when combined with bright lead, has a high electromotive force; oxygen makes lead rusty and hydrogen makes it bright. His battery consisted, then, of two lead plates suspended in water, which contained a little sulphuric acid to assist in the conduction. When a current of electricity was passed through, hydrogen was thrown off at one plate, making it bright, and oxygen at the other plate, peroxidizing its surface. When the charging source was removed, the altered plates would send off a current, which was in a direction opposite to the one which had charged them, and this would keep up until the plates had assumed their original condition.

Planté's choice of materials was most wise, and all practical storage batteries of to-day are but modifications of his style.

In order that his battery might give a strong current, and one that would last a long time, it was found necessary that his two lead plates should be as near to each other, and that they should be as large as possible. He accomplished both of these ends with economy of space by winding large plates into a spiral form, they being separated from each other by strips of rubber.

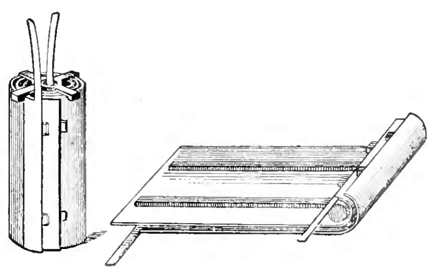
In charging this battery, care must be exercised that the current be not too strong; otherwise the gases would be sent off too rapidly for the lead to take them up, and they would then rise to the top of the liquid and escape into the air. The electrical energy which separated them would thus be lost. It accordingly takes a long time to charge a new Planté battery to its full capacity. After being subjected to the current for a day or two, if the plates be removed and examined, it will be found that the one which received the oxygen has changed its physical character: instead of having a smooth surface, it presents a spongy appearance, having little holes and cavities in it, and thus exposes a larger superficial area.



PLANTÉ'S ACCUMULATOR.

If the battery be now discharged, and be again subjected to the charging current, it will be found that a much stronger current may be used than at first, without any gas escaping. This is owing to the much larger surface exposed and to the spongy character of it.

This original charging of a new battery, to change the character of the lead surfaces, has been termed *formation*, and, inasmuch as only one plate is altered by a charge in one direction, a complete formation consists in a charging in two directions.



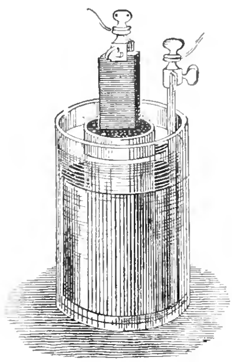
PLANTÉ'S ARRANGEMENT OF PLATES.

As the process of electrical formation is necessarily an expensive one, it was thought that the same end could be attained by mechanical means. Planté himself suspended the lead plates, for a few days, in strong nitric acid. The acid does not attack the lead, but seems to dissolve out small impurities, which are distributed throughout the metal, leaving it in a much more porous condition than after electrical formation.

Others cut the plates into fine fringes, thus exposing a large surface with a small weight of lead.

D'Arsonval, instead of using plates, employed lead shot, thinking to get the largest surface for the given weight. The particles could be effective, however, only under the condition that they were in good contact with the wires leading to the battery. After becoming oxidized, a large proportion of the shot did not satisfy this condition, and the method was abandoned.

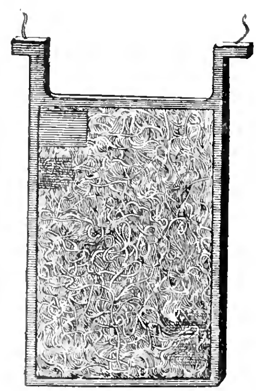
Lead wire was then substituted for the shot, and was found very efficient. Lead wire, however, is very expensive; and, to obviate this, Simmen invented a very ingenious and economical process of manufacturing it. This consists in pouring molten lead into heated iron boxes, the bottoms of which are perforated with suitable-sized holes. The metal flows through these holes, and is suddenly cooled by dropping into cold water. The wire thus manufactured does not possess the same regular character as drawn wire, but is perfectly suited to the purpose for which it was intended. The wire, after removal from the water, is compressed into sheets, which, under the microscope, resemble, in texture, coarse felt. Simmen placed pieces of this felt in frames of cast lead, which acted as supports and improved the electrical contact.



Lead-shot Accumulator.

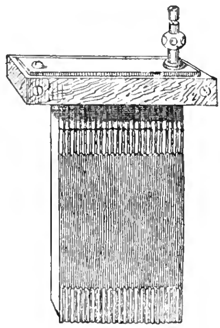
Reynier sought to increase the exposed surface by taking thin lead foil and forming it into accordion-plaits. The compressed plaits were then attached to supporting frames.

When Reynier's battery was charged, an unexpected phenomenon presented itself. The lead, in taking up the oxygen, had increased its weight. At the same time it had been transformed into peroxide of lead, which is less dense than pure lead—i. e., a pound of it would occupy more space than a pound of the metal. The plaits, therefore, required more room, and in expanding they buckled the frames holding them. To obviate this, Reynier then cut a longitudinal opening in the plaits after they had been placed in the frame, and when the battery was charged this opening was closed by the expansion.

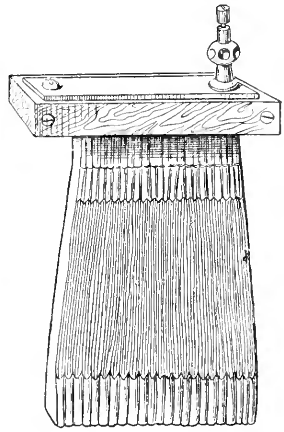


Lead-wire Plate.

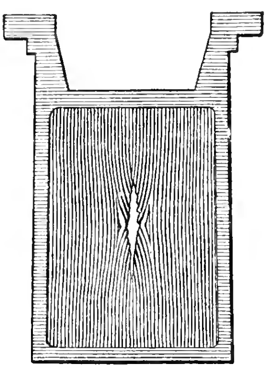
In all the styles of lead batteries mentioned, the oxide of lead on one plate and the spongy metallic lead on the other were formed from the lead of the electrodes themselves. Camille Faure, however, lessened the loss of time in formation by using lead plates as a support, and covering them with a paste made of some powdered oxide of lead mixed with sulphuric acid. This paste he kept in place by covering with sheets of felt. When the charging current was connected, the oxide on one plate was changed to a higher oxide, and on the other plate transformed into metallic sponge. This idea of Faure was an excellent one, and is at the foundation of the construction of all the commercial lead accumulators. The percentage of energy recovered by discharge was greatly increased. His method of keeping the paste in place by felts was, however, soon abandoned, because fine lead needles soon filled up the interstices of the felt, and thus made a metallic connection between the electrodes. Holes were then punched in the lead plates and the paste pressed into them. A large number of the patents recently issued for accumulators refer to methods of making these holes and pressing in the paste, or to the shape of the holes themselves after they have been punched. The shapes vary from a slight depression on the surface to a hole completely



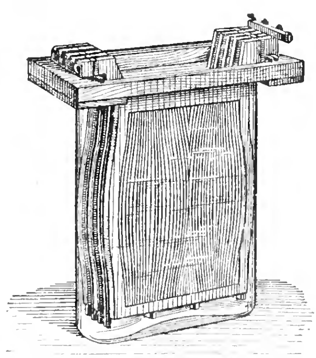
REYNIER'S PLAITS (uncharged).



REYNIER'S PLAITS (charged).



REYNIER'S MODIFIED PLAITS (uncharged).



REYNIER'S MODIFIED ACCUMULATOR (charged).

through the plate, and even further, to a hollow plate, with small openings leading to the surface. A great deal depends upon this shape, for the paste changes its volume during the process of charging and discharging, the same as the metallic lead does, and it would tend to loosen itself from some shaped openings and fall to the bottom of the cell, while in others it would tend to tighten itself, and thus provide a better contact.

Although the electrical end is obtained by substituting paste for metallic lead, yet this does not prevent the charging current from attacking the lead frames which hold the paste. These in time are rendered porous, and after a while they break under their own weight. To avoid this, alloys and many secret compo-

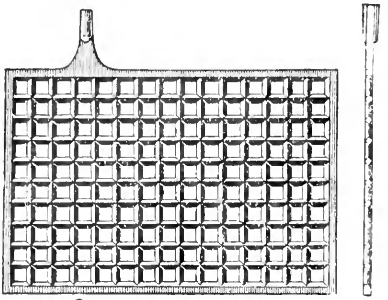


Plate with Holes of Larger External Diameter.

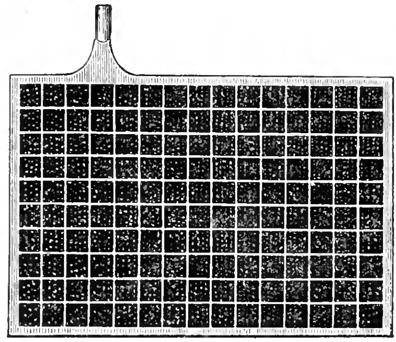


Plate with Holes of Larger External Diameter (filled with paste).

sition metals have been substituted for the lead frames. Even then, the continual change in volume of the paste contained in them twists and warps them so that new plates have to be substituted after a while. No good battery has yet been constructed which can be said to have a reasonably long life.

From what has been said it will be seen that the electricity which is used for charging an accumulator is apparently used in

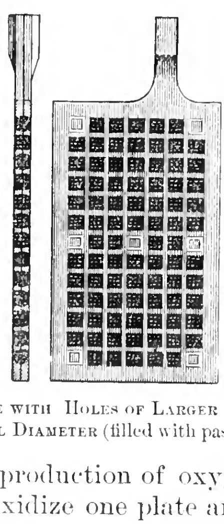
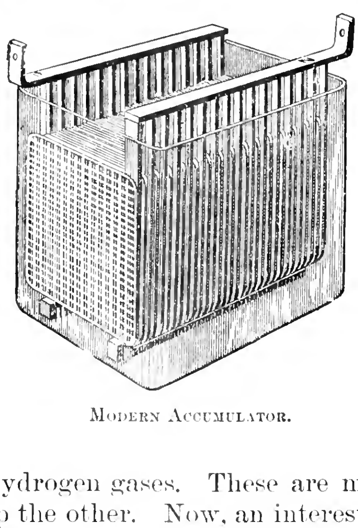


Plate with Holes of Larger Internal Diameter (filled with paste).



Modern Accumulator.

the production of oxygen and hydrogen gases. These are made to oxidize one plate and clean up the other. Now, an interesting question arises, whether it would not be more economical to employ gases, which can be more cheaply produced through chemical means. Difficulties, however, arise here, for the oxygen of electrolysis is generated in the form of nascent oxygen, which is far more active than ordinary oxygen. A molecule of the ordinary gas contains two elementary atoms, which work upon each other; with the electrolytic generation, however, a single atom is sent off, and this is chemically very active. It is sometimes called ozone; but chemists say that a molecule of ozone contains three atoms. Now, there is no known method of chemically manufacturing ozone in large quantities, and ordinary oxygen does not produce the required effect.

Again, Planté's supposition, that the charging current produced these two gases only, is incorrect. The sulphuric acid in the water, which he supposed only assisted in the conduction, really acts upon the lead in forming lead sulphate. This has its use in preventing the charged battery from running down when not in use, and from too rapidly expending itself when put to use.

A more perfect system of storage batteries is much to be desired. Already electricity is a staple article, and has a market price of so many cents per ampère-hour. But its sale is of necessity confined to limited areas. As soon as these can be extended, by means of storage, an improvement in our commercial welfare will become apparent, and the fear arising from the predicted loss of our coal-supplies, will not trouble the minds of our immediate posterity.

ELEMENTARY BOTANY IN GENERAL EDUCATION.*

By Prof. MARSHALL WARD.

As I understand it, we may regard the study of botany as approachable from three points of view. We may speak of three ends to be attained: those of (1) elementary botany as a school-subject of general education; (2) advanced botany, as a subject of university or academic training, with a view to teaching and research; (3) special botany, for various purposes in after-life—e. g., those of foresters, planters, agriculturists, horticulturists, brewers, medical men, timber merchants, etc.

This is, of course, a merely aribitrary division for the argument, and not a philosophical classification of the subject-matter of the science of botany.

The next point is the scope of the teaching in each case. I should advocate that all children pass through the preliminary training embraced under No. 1. Not only so, but I would urge the usefulness and importance of elementary botany in schools quite apart from its possible pursuit afterward.

* From a discussion at the Leeds Meeting of the British Association for the Advancement of Science, reported at length in Nature for October 23, 1890.

It seems to me that the time is gone by when we need discuss the direct applicability of teaching in elementary schools; if school training is read to mean education in the true sense of the word, then there is no necessity for asking that a boy and girl should learn at school only those subjects of which they will make direct application as they grow older. Of course, this does not preclude our keeping in mind the relative utility of the various subjects to be taught, but it does—and emphatically—preclude our falling into the error of imagining that a school-subject is of educational value only in proportion to its direct and foreseen utility in the application afterward. In other words, education and teaching may be, and often are, very different things.

Now, as I understand it, the nineteenth century has discovered—possibly rediscovered—the truth that you may impart a wondrous amount of information to a boy or girl without awakening those powers of observing and comparing that lie dormant in the minds of most healthy human beings, and especially when young; and that many a brilliant boy grows up without being able to draw correct inferences from the phenomena around him, and therefore less able than he should be to hold his own in the world he awakes in.

The peculiarity of the study of elementary botany, properly understood and pursued, lies especially in the interest it arouses in the child's mind, and the ease with which it may be taught, and I would insist and reinsist on the fact that it stimulates and cultivates just those powers of accurate observation and comparison, and careful conscientious recording of the results, which are so needed by us all; and which, be it understood, moreover, come so naturally to children who are not too much under the baneful influence of the mere instruction—the mere information—system.

What I wish to emphasize is that the educational value of this subject is no more to be measured merely by the number and kind of *facts* which the child remembers, than is the educational value of history to be measured by the dates learned, and the lists of kings and battles committed to memory. History, reading and writing, arithmetic, and other subjects, have an educational value, if properly taught, quite apart from their value as mere accomplishments, which may be granted; but children are naturally observers, and why this side of their hungry little natures should be starved at the expense of their usefulness in after-life has always been a mystery to me.

To those who allow this, and I am happy to see that their numbers are now many, it should hardly be necessary to point out that the elements of botany afford the cheapest, cleanest, and most easily attained means of cultivating in children the powers of observing and comparing direct from Nature, and of leading them to generalize accurately.

Of course, no advocacy is needed for good preliminary education in elementary botany in the case of those who are about to continue the pursuit of the subject as an academic study, or for a special purpose, as noted under the headings (2) and (3); but a few words may be devoted to pointing out the shocking waste of time and energy on the part of all concerned in the prevailing cases where students come up to a university, or other institution for higher education, insufficiently prepared for progressive study.

It is still true that boys and young men leave school without so much as a notion of the real meaning and aims of science; this applies no less to subjects like physics and chemistry, which are professedly much taught in schools now, than to subjects like natural history and botany, which, though avowedly in the curriculum of some good schools, are usually entirely ignored.

There is considerable discussion about the details, but many practical teachers regard such subjects as unfitted for school, because the boys and girls soon cease to be interested, and get lost in the masses of facts and hard names that beset their path; this, to my mind, simply shows where the whole system is wrong, and wrong because the tyrant empiricism still rules the prevailing methods of teaching in schools

I shall go so far as to say that the only remedy for this state of things is for the teachers to lose that blind worship of facts, as facts, which dominates our school system. I am aware that this lays me open to very serious misconstructions, but I hope to make that all right in the sequel.

I would say to the teachers, therefore, Do not fall into the mistake of measuring a boy's progress by the amount of dogmatic information which he imbibes, and splutters forth upon his examination papers, but look to the quality of his understanding of the relations between relatively few and well-chosen facts; and again, pay less attention to the number of facts which a boy observes and of names he remembers, and more to the way in which he directly makes his observations, and intelligently describes them, even if untechnically.

This is, I firmly believe, the only cure for the malady under consideration—i. e., it is the prevention of it.

Children in schools are taught most subjects from printed books, and it is not my province to criticise the necessity of this as regards those subjects; but let a competent teacher try the experiment of making the children read directly from Nature, and he will soon see that the new exercises have a powerful effect. They will stumble, and they will even make stupid mistakes and mispronunciations; but do they not do so when they are reading—i. e., observing and comparing and interpreting—printed words in a book? Of course they do, and therefore the teacher must not be discouraged by their stumbling and misapprehending when first they have to look at and compare different leaves and flowers, and give forth the articulate sounds which correspond to the impressions created on their minds.

Every weary teacher knows what a blessing is variety in the studies of the class, and it passes my comprehension why advantage is not taken of the splendid opportunity offered by the study of elementary observational botany.

We now come to the important subject of method. How should botany be taught?

Elementary botany in schools should be confined to lessons in observation and comparison of plants, and the greatest possible care should be taken that books are not allowed to replace the natural objects themselves. Indeed, I would go so far as to advise that books be used only as an aid to the teacher, were it not that a judiciously written text-book might be employed later on by even young children as a sort of reading-book.

The chief aids should be the parts of living plants themselves, however, and, in spite of the outcry that may be expected from pedantic town teachers, I must insist that every school might be easily provided all the year round with materials for study. I even venture to think that these materials might be collected by the children themselves; at any rate, there should be no difficulty about this in the country.

I will illustrate these remarks by a few examples. The teaching of elementary botany to children should commence with the observation of external form, and might well be initiated by a comparative study of the shapes of leaves, the peculiarities of insertion, their appendages, and so on.

The point never to be lost sight of is that if you teach a child to discriminate, *with the plants in hand and from observation only*, between such objects as the simple, heart-shaped, opposite, ex-stipulate stalked leaves of a lilac, and the compound, pinnate, alternate, stipulate leaves of a rose, you lay the foundations of a power for obtaining knowledge which is in no way to be measured merely by the amount or kind of information imparted. It does not matter whether the child learns the trivial facts mentioned above, or not, but it is of the highest importance that the child be taught how to obtain knowledge by such direct observation and comparison; and the beauty of it all is that, as is well known, the child will retain most of such information as mere matter of course.

For the main purpose in hand, therefore, it may be contended that any objects would do.

This is no doubt true in one sense, but it should not be forgotten that (1) the mental exercise on the part of the child is best exerted on *natural objects*, to say nothing of the admitted advantages of familiarizing him with Nature; and (2) the parts of plants are so varied, so beautiful, and so common, that he need never lack materials for his simple and pleasant work. Moreover, the parts of plants are clean, light, and easily handled—practical advantages which recommend themselves.

I feel convinced that, if the teachers were not opposed to it, the subject would ere now have been more widely taught; and I shall therefore say a few words in anticipation of difficulties. It has been suggested that materials would be scarce in winter. Not at all. Let the children be familiarized with the observation and comparison of the peculiarities of a sprig of holly as contrasted with one of ivy; or let them be shown how different are the buds and leafless shoots of the beech from those of the oak or the horse-chestnut. Show them how to observe the bud-scales, how to infer the leaf-arrangement from the scars, how to notice the color, roughness, markings, etc., of the periderm. Or give them introductory notions as to the nature of a hyacinth bulb as contrasted with the potato tuber, confining their attention to points which they can make out by observation. Every nut or orange or apple that the child eats might be made interesting if teachers would dare step over the traces of convention, and introduce such ostensibly dangerous articles into class-work—and why not? The doctrine of rewards and punishments is applied more crudely than this in most children's schools!

Be this as it may, there is no lack of material, at any season, for children to observe and compare, plant in hand, the peculiarities of shape, color, insertion, markings, etc., of the leaves, stems, roots, and other parts. The difficulties are supposed to increase when the flower is reached; this is not necessarily the case in the hands of a sympathetic teacher, unless the choice of flowers is very unfortunate and limited.

There is one danger to be avoided here, however. Young children should not be troubled with the difficulties of theoretical morphology; they should be made familiar with the more obvious roots, stems, leaves, tendrils, thorns, flowers, bulbs, tubers, etc., as such, and comparatively, and not forced to concern themselves with such ideas as that the flower is a modified shoot, the bulb a bud, the tendril a leaf or branch, etc., until they have learned simply to observe and compare accurately. Later on, of course, the step must be taken of rousing their minds to the necessity of drawing further conclusions from their comparative observations in addition to recording and classifying them; but, if the teacher is really capable of teaching, it will be found that the children begin to suggest these conclusions themselves, and, this stage once reached, the success of the method is insured.

Glimpses of the meanings of adaptations of structure to function soon follow, but they should be obvious and simple at first, and the mistake should not be made of entangling a child in a discussion as to more remote meanings. It should never be forgotten, in fact, that the first steps consist in learning to observe accurately and to record faithfully, comparative exercise being used in addition, both as a check and as a stimulus to the judgment.

THE INTELLIGENCE OF CATS.

By W. H. LARRABEE.

QUESTIONS concerning the quality or faculty in animals comparable with human reason and the extent to which it is developed in them are much discussed. Mr. Romanes discriminates between those ideas of quality that spring from mere sensuous impressions and those elaborated notions that arise from the more complex associations supplied by mental reflection, and assumes that brutes have a power of thought of the former or inferior order. The Rev. George Henslow admits that they reason as we do, but always in connection with concrete phenomena, whether immediately apprehended by the senses or present to consciousness through memory; but that they have no power of conveying truly abstract ideas. Prof. Exner regards them as capable of certain determined combinations in view of specific ends which are variable within very narrow limits. Some of the recorded instances of the exercise of thought by animals suggest that the sphere of their action in this line is often capable of considerable enlargement.

In a former article were considered some of the friendships which cats appear to form with human beings, particularly with the members of the families in which they live. The discussion might be continued indefinitely, and illustrated by incidents without number. Of equal interest are the associations which they are capable of forming with other animals.

We have only an imperfect knowledge concerning the relations of different animals toward one another. We can conceive the relative feelings of an animal that pursues and one that is pursued, and can comprehend that there should be jealousies and disputes between rivals for the same prey. We perceive animals of social habits mingling across the lines of species without much difficulty, and also, perhaps, without much real intimacy. But there are a large class of other animals that are naturally neutral as toward one another, concerning whose mutual attitudes an ample field for inquiry is open. Cats belong to a family of soli taries. In a state of nature they form only passing relations, and have more quarrels than friendships with members of their own species. We should hardly expect them to be particularly sociable, or even friendly, across the line. Yet they can be made to form companionships when brought into association with other animals under the same roof, and some that seem very strange to the superficial view. The term "cat-and-dog life" is frequently used to describe a condition of discord; but cats and dogs often dwell very harmoniously together. Lindsay regards the phrase as implying an insult to both animals. Both he and Wood assert that the two can be trained to be very good friends, and that when this occurs "the cat usually behaves in a tyrannous manner toward her canine friend," and treats him most unceremoniously. "She will sit on his back and make him carry her about the room; she will take liberties with his tail, or bite his ears, and if he resents this treatment she deals him a pat on the nose," * and raises her back at him or retires till his good humor returns to him. The description will be recognized in thousands of families as acurate. Wood supplements his observation with a story of a cat and dog who had become great friends, when the dog was taken away. He afterward returned, with his mistress, on a visit. "Pussy was in the room when the dog entered, and flew forward to greet him; she then ran out of the room, and shortly returned, bearing in her mouth her own dinner. This she laid before her old friend, and actually stood beside him while he ate the food with which she so hospitably entertained him." † The natural attitude of the dog and cat may be regarded as one of rivalry for the same food and attention, and therefore of jealousy. The dog, being usually the larger and stronger animal, is likely to look upon the cat as his victim. This excites distrust and hostility in her, and the foundation of a feud is laid, which can be repressed or cultivated. An unnamed cat in Belfast, Maine,‡ became attached to a pig, and was its constant companion—sleeping with it at night and following it about by day. When Piggy was slaughtered, Pussy's grief was "pitiful to see. She watched by the lifeless body all night, and was found there in the morning; and could never be persuaded to eat a mouthful of its pork." Tabby, of Belfast, who had a kitten, became interested in a pig which

* Wood. † This story was told to Mr. Wood by the owner of the cat.

‡ The cat stories from Maine are cited from the Belfast Republican Journal.

had been brought half frozen to the house to be taken care of. She was found in his box trying "to quiet him and get him to accept her as his mother. Her kitten would cry, and she would leave the pig for a few minutes and go and quiet that, and then she would go back to the pig and try her best to make him comfortable." At last she took her kitten into the box with the pig. Rosy, an excellent ratter on a Belfast schooner, made friends at once with a pet rat that was brought on board, slept and played with it for two weeks, and allowed it to take many liberties with herself. Don Pierrot de Navarre and Seraphita, cats of Théophile Gautier, lived on the most friendly terms with their master's troop of white rats. Don Pierrot was especially fond of the rats, and would sit by their cage and watch them for hours together. If the door of the room where they were kept happened to be shut, he would insist, by scratching and mewing, on its being opened to him. Tabby, of Hyde Park, near Boston, having lost her kittens, took a brood of motherless chickens under her care. Knowing of them, she begged to be admitted to them. The experiment was tried. She looked at them a moment, then sprang into the box and, purring, nestled down among them. This was the beginning of a constant service of six months, during which Tabby would play with the chickens; would try to carry them by the neck as she would her own kittens; and persisted in licking their feathers the wrong way.

Mr. J. M. Coffinberry, of Cleveland, Ohio, writes to us that when, some forty-three years ago, he took possession of a certain house in Findlay, Ohio, the attention of the family "was called to a brood of young chicks by a cat who seemed to devote her time and attention to them. The ground being covered with two or three inches of snow, my wife fed them regularly, so that we saw much of them. The cat frequently purred to them, and they came at her call and followed her as closely as young chickens follow the mother hen. They lodged together in a wood-shed adjacent to the house for about three months, but in the early spring the chickens, being well fledged, abandoned their winter quarters and flew into the higher branches of a fruit tree to roost. The cat purred and mewed, and seemed much disgusted at their change of lodgings, but soon accepted the situation and climbed to the tree-top and roosted with the chickens." This continued during the few months that the family occupied this house. Mr. Coffinberry asks some questions as to what was in the cat's mind or heart that prompted her to this parental act. It is easily explained if the qualities which he and many authors claim for cats are conceded to them. A correspondent, M—— C——, of Nature, tells of a cat and dog who, having been brought into the family at about the same time, grew up friends and fast companions. They ate out of the same dish and slept on the same mat. The dog took the cat under his protection, and was particularly assiduous in defending his ward from a vicious black cat that troubled it. A correspondent of the London Spectator wrote concerning tomcat Blackie's interest in a dog who had been blinded by a carter's whip and had been nursed by his master. Observing that "Laddie" (the dog) had difficulty in finding his way to the door, and sometimes struck his head against the posts, she became accustomed to go for him when he was called and guide him in.

Wood gives, in his Natural History, an account of two cats called the "Mincing Lane Cats," who lived in a wine-cellar, and, one being old and the other young, appear to have agreed upon an interchange of services. "Senior" taught "Junior" to avoid men's feet and wine-casks in motion, and pointed out the best hunting-grounds, while "Junior" employed his youthful activity in catching mice for his patron. In consideration also of the mice, Senior gave up to Junior a part of his share of the daily rations of cat's meat. It is represented that the curious compact was actually and seriously carried out. This had the air of a commercial transaction, but another story told by Mr. Wood exhibits pure benevolence. A cat in a Norman château had every day more food than she could consume, and the waste of the surplus "seemed to weigh on her mind." So one day she brought a less well-fed cat from a roadside cottage, and, having satisfied herself, gave it what was left. Her master, observing this, gave her larger platefuls, when she brought in another cat from a greater distance. The master then determined to test how far the cat's hospitality would extend, and kept adding to the platefuls from time to time, as new cats were brought in, till Puss's dinner-party included nearly twenty guests. "Yet, however ravenous were these daily visitors, none of them touched a mouthful till their hostess had finished her own dinner." * An Angora cat belonging to M. Jumelin † would often bring a poor, half-starved cat home with him, and then would see that it was fed. On the last occasion of his doing this, "Master Cat seemed nervous and excited, and behaved as though he thought the case was urgent. He became more quiet, however, as soon as the dish was set down for the strange cat, and contentedly observed what was going on while the visitor was taking his meal. As soon as the dish was emptied he showed his guest to the door, bade him good-by with a friendly but lively stroke of his paw, and accompanied him down the stairs, addressing him a succession of friendly mews."

* Mr. Wood's informant had this story from the owner of the château.

† Revue Scientifique.

Cats appear taciturn in ordinary life, but every one knows that they can upon occasion, and that often, speak forcibly enough. They also have a language for their friends, varied and expressive enough to convey their wants definitely, and make intercourse with them pleasant and lively. Those who know them best may readily say, with John Owen, in the London Academy:

> "Thou art not dumb, my Muff;
> In those sweet, pleading eyes and earnest look
> Language there is enough
> To fill with living type a goodly book."

Montaigne observed, some three hundred years ago, that our beasts have some mean intelligence of their senses, well-nigh in the same measure as we. "They flatter us, menace us, and need us; and we them. It is abundantly evident to us that there is among them a full and entire communication, and that they understand each other." Dupont de Nemours, who undertook to penetrate the mysteries of animal language, recognized that animals had few wants, but these were strong, and few passions, but imperious, for which they had very marked but limited expressions. He thought the cat was more intelligent than the dog, because, being able to climb trees, she had sources of ideas and experiences denied to him; and, having all the vowels of a dog, with six consonants in addition, she had more words. The Abbé Galiani pretended to have made some curious discoveries respecting the language of cats, among which were those that they have more than twenty different inflections, and that "it is really a tongue, for they always employ the same sound to express the same thing." Champfleury professes to have counted sixty-three varieties of mewings, the notation of which, however, he observes, is difficult. The sign and gesture language of the cat is even more copious and expressive than its audible language. As Mr. Owen has it:

> "What tones unheard, and forms of silent speech,
> Are given that such as thee
> The eloquence of dumbness man might teach!"

Lindsay enumerates, as among the elements of the non-vocal language of cats, capers or antics, gambols, frolic, and frisking in the kitten; prostration, crouching, groveling, crawling, cringing, and fawning; hiding, flight, sneaking, skulking, slinking, shirking, or shrinking; rubbing against the bodies of other animals or against hard substances; licking; touching or tapping with the paws; scratching; head-shaking, tossing, or rubbing; and tail-movements, of which there are many. Dr. Turton says that "the cat has a more voluminous and expressive vocabulary than any other brute: the short twitter of complacency and affection, the purr of tranquillity and pleasure, the mew of distress, the growl of anger, and the horrible wailing of pain." Besides these, the expressions of the countenance, as Mr. Owen teaches in his poem, are as lively and varied in the cat as in any other animal. The well-bred cat can put these diversified means of expression to uses commensurate with nearly all her wants; and the sagacious and sympathetic master can with no very great difficulty learn to translate them as accurately as he responds to the wishes of his child.

Romanes gives several instances illustrating the applications of this sign-language. A cat, observing that a terrier received food in answer to a certain gesture, imitated his begging. Another would make a peculiar noise when it wanted a door opened, and, if its wish was not attended to, would pull at one's dress with its claws; then, having secured notice, would walk to the door and stop with a vocal request. Another cat, having found its friend the parrot mired in the dough, ran up-stairs to inform the cook of the catastrophe, "mewing and making what signs she could for her to go down," till at last "she jumped up, seized her apron, and tried to drag her down," and finally succeeded in getting her to rescue the bird. Other cats are mentioned which would jump on chairs and look at bells, put their paws upon them, or even ring them, when they wanted anything done for which the ringing of a bell was a signal.

The extent of the cat's understanding of human language must depend considerably on the treatment and training it receives. An animal that is treated unkindly or is neglected can not be expected to learn much beyond the knowledge which its natural instinct confers upon it. Another animal, not necessarily brighter, but having better opportunities and more encouragement, may readily acquire knowledge of all the things that it is important one of its kind should know. Cats having appreciative masters and playmates will gain a really remarkable degree of knowledge of the tones, gestures, words, thoughts, and intentions of their human friends. Many of the well-authenticated stories on this point reveal faculties of perception that must seem astonishing even to persons well informed respecting the mental powers of animals. Careful observation of his own puss can hardly fail to convince any one that they understand more of ordinary conversation, as well as of what is said to them directly, than we are apt, at first thought, to suspect. Lindsay has shown that, in common with other tamed and domestic animals, they understand one or more of the modes in which man expresses his ideas, wishes, or commands, as well as those ideas, wishes, and commands themselves, however expressed, particularly the calls to receive food, and their own names. They also, in common with a smaller number of animals, appear to know the names of the different members of the family, and of articles of domestic use. An instance is cited from Clark Rossiter of a cat that knew the name of each member of the household, and, his seat at the table. If asked about an absent one, she would look at the vacant seat, then at the speaker, and, if told to fetch him, would run upstairs to his room, take the handle of the door between her paws, mew at the key-hole, and wait to be let in.

The mistress of Topsey, of Belfast, an invalid, expressed a desire to have a partridge or a chicken for a broth. Some one spoke of having seen a flock of young birds in the morning, and immediately afterward Topsey sprang into the window with a partridge and laid it at her mistress's feet. The mistress commended the cat, and added, "If you will go and get another, you and I will have a nice dinner to-morrow." She went out, and shortly brought in another bird, which she also laid at her mistress's feet. Although very fond of birds, she declined to eat these herself. She was told not to catch any more birds, and brought no more to the house.

Dollie, of North Monroe, Maine, had one of her legs torn off by a railroad train. Her mistress, believing her case a hopeless one, begged two boys, in her presence, to take her away and kill her. "Instantly," says the teller of the story, "the look of patient trust with which she was regarding her mistress as she pitied and petted her, changed to one of terror as she got up and rushed out of the house." She was found, and fed, but would not return to the house till her wound was healed. Daisy, of Belfast, persisted in laying her kitten in her mistress's bed till the lady, looking her in the eye, told her if she did so again the kitten should be drowned, when she ceased offending. June, of Stockton, Maine, behaved in such a way as to lead the family to suppose that her kittens, which she had hidden under the floor of a back room, had died. The matter was talked about in the presence of the cat, who seemed to be sleeping on a lounge, and the relator of the story remarked that she "would give ten dollars in a moment if the kittens were out from under the floor." June rose at once and went to the door. It was opened for her, and she went up the stairs. After going up and down several times, she rattled at the door-knob; when the door was opened she looked into the lady's face and mewed. Three of her dead kittens were lying on the floor. The lady said: "Well done, June; go and get the other one." She went and brought it, then looked into the lady's face and mewed again. Spot, of Camden, Maine, answered when she was asked if she wanted anything to eat; and if her answer was negative, she would not eat, even if she was fed. Coonie, of Belfast, when directed in the morning to "go call the children," would go up the stairs, into every room, jump upon the bed and wake up each one; and, if it was early, would stay in the rooms a little while, but, if it was late, would hurry down-stairs. A cat at Poor's Mills, Maine, would hold up her right or left paw, or both, correctly, as she was directed, previous to receiving her food. Théophile Gautier's Eponine, a "delicate, lady-like cat," was allowed to sit at the table at dinner. Although she preferred fish, she would eat her soup first, when reminded, in polite language, that a person who had no appetite for soup ought to have none for fish.

Some of these acts may be only coincidences; but observation for ten years of my own cat, concerning whom it has often been remarked that she seemed to understand what we were talking about and was listening to it, has satisfied me that more of them were done with knowledge. The story of the adventure of Théophile Gautier's Madame Théophile with the parrot, on first being introduced to it, indicates a comprehension of the significance of language, and has its humorous side also. The cat, looking upon the bird as a "green chicken," stealthily approached it as with the intention of seizing it. The watchful bird, at the critical moment, asked her, in good French: "Have you breakfasted, Jockey; and on what—on the king's roast?" and broke out into song. The astonished cat retreated hastily, and hid for the rest of the day, but renewed her attack on the morrow, to be rebuffed in the same manner. From that time she treated the parrot with the respect due to a being having the power of speech.

Montaigne says: "When I play with my cat, how do I know whether she does not make a pastime of me, just as I do of her? We entertain ourselves with mutual antics; and if I have my own times of beginning or refusing, she, too, has hers." The sportiveness of kittens is exuberant, and makes them the most delightful of pets. Lindsay's remark is superfluous, except that it has to be made for the formal completeness of his treatise, that dogs and cats take part in the fun and frolic—sometimes rough or boisterous enough—of their child playfellows. They give every evidence, in fact, that such fun and frolic are the most enjoyed features of that period of their lives. As the animal matures it becomes more sedate, and even assumes a meditative air, but the taste for sport does not die out till infirmity begins to wear upon it. A cat mentioned in the Animal World would allow itself to be rolled up or swung about in a table-cloth, and seemed to enjoy the fun; and Wood's dignified Pusset would let his friends do anything they pleased with him—lift him up by any part of the body, toss him in the air from one to another, use him as a footstool, boa, or pillow, make him jump over their hands or leap on their shoulders, or walk along their extended arms, with perfect complacency. At the same time he was keenly sensitive to ridicule, and, if laughed at, would walk off with every manifestation of offended dignity.

Lindsay names the cat as one of the animals that perpetrate practical jokes on each other or on man; that enter thoroughly into the spirit of the joke or fun, and enjoy and exult in its success; and cites in illustration of his principle an instance of a cat teasing a frog, seemingly to hear it cry. Tad, of Burnham, Maine, seems to have had the humorous sense in a more refined degree. He would sit in the yard, and, calling the neighboring cats together, would manœuvre as though giving them orders, till he got them to fighting; then would withdraw to one side, or to his seat upon the window-sill, and look on in evident amusement, swinging his large, bushy tail forcibly against the window-pane; but, when called into the house by his mistress, he always obeyed.

Knowledge of the ways in which certain common things are done and the capacity to apply it are so frequently shown by domestic cats that it is almost superfluous to mention particular instances of its exhibition. Most cats know how doors are opened, and can open them for themselves if the method of handling the latch comes within the compass of their powers of manipulation. Romanes asserts that, in the understanding of mechanical appliances of this character, they reach a higher level of intelligence than any other animals, except monkeys, and perhaps elephants. He thinks that the skill of these animals may be due to their having, in their flexible limbs and trunks, instruments adapted to manipulation, which they learn to use. This may be so, but it should be remembered that horses can open doors and gates with their teeth and noses, and cows with their horns. The behavior of cats before a looking-glass, when, failing to find the image palpable in the face of the mirror, they look or feel around behind it, is familiar. Having once satisfied themselves that there is nothing there, they recognize the fact, and cease to take any further interest in the phenomenon. So they and other animals know that they can go round a wall and reach a point on the other side of it; or can go round after the mouse which they have heard rustling behind the door. A noteworthy feat of door-opening is recorded by Mr. Romanes of his coachman's cat, which, having an old-fashioned thumb-latch to deal with, sprang at the half-hoop handle below the thumb-piece, hanging to it with one paw, depressed the thumb-piece with the other paw, and with her hind legs pushed at the door-posts till the door flew open. Mr. Romanes interprets this and another similar action which he records as involving a deliberate purpose, combined with a mental process which he treats as complex and very near akin to reasoning, and as involving definite ideas respecting the mechanical properties of doors. Mr. A. Petrie's cat would climb up by some list to the click-latch, push it up, and, hanging from the door, similarly push it away from the posts. The cat of Mr. W. H. Michael, of Queen Anne's Gate, St. James's Park, London, jumped four feet to the crank-latch of a casement window, caught hold of the crank with her fore feet, and pressed the window open with her hind feet. A cat belonging to Parker Bowman learned to open a window by turning a swivel and bearing upon the sash.

Some equally curious incidents, showing powers of contrivance and a degree of understanding of the relation of antecedent and consequent, are connected with cats striking door-knockers and ringing bells, or, if unable to do so themselves, asking to have them done. Mr. Belshaw tells, in Nature, of his kitten jumping upon the door and hanging by one leg while it put the other fore paw through the knocker and rapped twice. A London cat is described in Nature which by standing on her hind legs would reach the knocker and rap once; if this was not answered, she gave what is called a 'postman's knock'; and if this was not responded to, "tried a scientific rat-tat that would not disgrace a West End footman." It is added that she held the knocker in her paws as we would hold it in our fingers, and did not simply tip it up. Mr. J. J. Cole's cat, of Maryland, Sutton, Surrey, having observed that a servant went to one of the windows after hearing the flap of a letter-box attached to it moved by a postman, learned to have herself let in when shut out by also rattling the flap. Some alarm was excited at Mr. Lonergan's house in London by a mysterious knocking at a door which could not be reached from the outside except by climbing over a wall. At length, Mrs. Muffins, the cat, was detected as the author of the sounds, and it was found some time afterward that she had learned to produce them by pulling at the loose lower end of a strip of board running down at the side of the door, and allowing it to rebound. There is perhaps nothing very remarkable in an animal, having observed that the striking of the knocker or the pulling of the bell-knob was usually followed by the opening of the door, learning to imitate the act. But some cats have gone further than this, and have learned the connection between the wire and the bell, and to avail themselves of it in order to be let in.

Other acts are related of cats that give us a much higher conception of their mental powers, and even go a little way toward lifting them into the order of beings capable of real abstract reasoning. Kitty, of Belfast, Maine, having given a mouse to her kittens to play with, watched the sport for a while as if to see that the mouse did not escape, but at last bit it so as to disable it, and then went away. Two kittens, neighbors of Kitty's, disagreed over a squirrel which had been given them. Their mother cuffed them, then bit the squirrel in two, and gave half of it to each. Coonie, of Belfast, sitting on the window-sill by the side of the ladies of the family when the glass was much clouded, put up her paw and wiped off the mist. This act may be matched by animals breaking ice to get at the water, and horses scraping the snow from the ground to reach the grass beneath it, but it also shows capacity for adaptation to circumstances. The same Coonie usually had to suffer the loss of all but one of each litter of her kittens. She finally seems to have determined to choose the one that should be saved. She selected one, carried it away, and left the rest to their fate. A Scotch cat, of Greenock, where the family were in the habit of throwing out crumbs for the birds, hid in the shrubbery to catch one of the birds when they came up. One afternoon the crumbs were not eaten, and were covered with snow during the night. In the morning, Puss was observed picking the crumbs out of the snow and putting them on top, after which she retired to her hiding-place. This was noticed two or three times; and at last Puss's success in catching the birds forced the family to cease feeding them. Dr. G. Frost, of London, found his cat in the habit of waiting in ambush for the throwing out of crumbs for the birds. The practice of feeding the birds was left off for a few days; and Dr. Frost avers that he and another member of the household saw the cat herself scattering crumbs on the grass, "with the obvious intention of enticing the birds." * Mr. James Hutchings tells, in Nature,† of a cat which, finding a young blackbird fallen from its nest to the ground, spent several hours in keeping a strange kitten away from the young bird, and at the same time herself teasing it, in order to entice the parent, which was hovering around, within her reach. The cat showed wonderful persistency through several defeats, and played a variety of tricks to deceive or attract the parent bird, till Mr. Hutchings forcibly put an end to the cruel sport. A cat living in a hospital in Massachusetts is described in Nature, which discovered the blindness of one of the inmates, and regularly took advantage of the fact to steal a part of her meal from her. Mr. Lawson Tait relates that a mutual dislike arose between a visitor at his house and his family of unusually intelligent cats. Although the cats had always been scrupulously neat and clean, they regularly left a noxious mess at the guest's room door so long as he stayed at the house. Just as the slaughter of the whole tribe as nuisances had been determined upon, the visitor went away, and the objectionable deposit ceased.

A story is told in the Hartford Times of a cat which became

* Nature, vol. xix, p. 519.

† Vol. xii, p. 330.

very uneasy one summer midnight and ran from one bedroom-door to another with earnest mewing and crying. Having attracted the attention of one of the family, she led the way, watching carefully to see that she was followed, down the stairs and through the kitchen and cellar to the outside cellar-door, which had been left open. A house between Belfast and Hollywood, Ireland,* taking fire one night, the cat ran up-stairs to the servant-maid's room and pawed her face. The girl, only half aroused, turned to sleep again. After a few moments the cat returned and scratched the girl's face till she woke in earnest, and now smelling the smoke, aroused the rest of the family. The cat already mentioned, that went and brought help to deliver the parrot from miring in the dough, evidently realized the nature of the danger the bird was in, and how it could be remedied. Mr. James R. Gilmore's (Edmund Kirk's) cat, finding one night, when she came home from her rambles, that the door leading to the veranda was open, took pains to give notice of it to the family. The same animal, when the family were all in other parts of the house, ran up to her mistress and demanded to be followed. She led the lady directly to the kitchen, and there was a strange man who had intruded himself into the vacant room. Mr. Gilmore relates several other anecdotes of this cat, which show that she understood the value of human help in emergencies—particularly in cases where her kittens were in trouble—and upon whom to call. She also understood that whatever demands she might make upon her master in the daytime, his night's rest must not be disturbed. At that time she always went to her mistress.

A cat is told of in the Boston Post which was accustomed to go in the summer with the family to the country. On the occasion of one of the vacations she appeared anxious about her kitten, and at last put it in one of the trunks.

A cat and a starling belonging to Mr. Dupré, of Kensington, England, were great friends and almost constant companions. One day the cat suddenly pounced upon the starling, but, instead of making an end of it, took it carefully up and set it upon a table; then rushed out of the room to chastise a strange cat which had stolen into the house. The forethought it exhibited in securing the safety of its friend before going into the fight seems to justify our attributing to it the highest degree of intelligence which any of the authors we have quoted are willing to accredit to animals.

A cat of Mr. Brown, of Greenock, Scotland, having had some paraffin accidentally spilled upon it and set ablaze by a cinder from the fire, at once rushed out of the door and up the street for about a hundred yards; plunged headlong into the village water-

* Nature.

ing-trough; and then stepped out, shook herself, and trotted quietly home. She had been accustomed to seeing the fire put out with water every night.

Mr. J. Harvey Gibbons's cat, of University College, Liverpool, when indisposed at one time, wandered strangely about the house, with an evident inclination toward the coal-bunkers. They were left open for her, and she went to them at once, and searched among the coals till she found a piece covered with pyrites. She licked this vigorously, and afterward returned regularly to the bunkers for more of the medicine. Some powdered sulphur was given her, and was accepted as a substitute for the pyrites. Under this regimen she recovered her health.

A most remarkable story illustrating this trait is told in the Revue Scientifique by Dr. Cosmovici, of Roumania, concerning his cat Cadi. We may remark that this gentleman appears to have been a keen observer of intelligence in all animals. The winter of 1880 was very cold, fuel was high, and our doctor had to be economical. He was accustomed, therefore, after his morning fire had burned out, to work during the rest of the day wrapped in furs, while Cadi sat at his feet. On one of the cold days, Cadi would every once in a while go to the door and mew in a tone quite distinct from that of his usual requests. Dr. Cosmovici opened the door, and Cadi went half-way out, looking at him the while. He shut the door and Cadi came back and mewed. At last he gave himself up to the cat's desire and followed her. She led him straight to the kitchen, and thence to the coal-box, and got upon it without ceasing to look at her master. He got coal. Cadi next showed him the way to the wood-box; thence led him back to his room, and, once within it, to the fireplace, where she lifted herself up and arched her back. The fire was made, while Cadi looked on, manifesting her approval of the operation by caresses. When it began to burn, she stretched herself before it, satisfied.

PREDISPOSITION, IMMUNITY, AND DISEASE.

By W. BERNHARDT.

IT is a generally recognized fact that whole classes and families of animals, as well as single individuals, frequently are liable to succumb to some influence apparently obnoxious to health, while others, although exposed to the same danger, prove exempt from such injury. This experience concerns the action of vegetable and animal poisons, as well as the attacks of the various diseases to which flesh is heir. Destitute of a satisfactory interpretation of these divergences, we have recourse to the expression "predisposition" for explaining the inability of offering resistance to the foe—a word which does not actually explain the matter, but furnishes a convenient term. Germs of disease are to be found everywhere, but only predisposition permits its development. Immunity, on the contrary, is the condition of the system which prevents an outbreak. The fundamental cause of this condition is as little known as the cause of predisposition; only in a few cases have we been successful in tracing it back to certain chemical and physiological processes occurring in the body.

The action of carbon monoxide on different animals affords a suitable instance of what is called immunity, and illustrates the kind of circumstances on which it may sometimes depend. Carbon monoxide is an air-like compound, which is contained to a large amount in the illuminating gas produced by the decomposition of steam by red-hot coals, and to the presence of which the poisonous qualities of this gas are chiefly due. A mixture of one part of carbon monoxide and ninety-nine parts of common air, when breathed, will in a short time kill any of the warm-blooded vertebrates. Cold-blooded vertebrates, such as frogs, can for a considerable length of time stand the exposure to such an atmosphere; arthropoda or insects are not in the least affected by it—they possess immunity from it. Searching for the cause of these differences of effect, we find it to be the tendency of hæmoglobin, the albuminous matter constituting the red corpuscles of the blood, to combine with carbon monoxide. In the process of respiration in warm-blooded animals hæmoglobin takes up oxygen, which thereafter, as a necessary agent in the exchange of matter, is delivered to the different organs of the body. Carbon monoxide prevents the absorption of oxygen, being absorbed in its place; but, unfit as it is to replace oxygen in its vital functions, it causes serious derangements, which end in suffocation. In cold-blooded vertebrates respiration is of more subordinate importance; although, as well as in warm-blooded animals, it consists in absorption of oxygen by hæmoglobin, the need for oxygen is much lower; a frog can live for a considerable time without the accession of air. Hence the effect of carbon monoxide is a much slower one. The blood of insects contains no hæmoglobin; carbon monoxide is not absorbed by it, and is not a poison to them, provided that a sufficient amount of oxygen is always present. Carbon monoxide, consequently, acts as a strong poison upon warm-blooded animals; its effect is weaker in cold-blooded vertebrates; and insects are proof against its effects.

In a few instances only has the cause of immunity become as well disclosed as in the one mentioned. Neither differences of organization in animals nor in the constitution of the poisonous substance generally afford any clew for interpreting an exceptional want of effect. Unaccountable is the immunity of rabbits against belladonna leaves (*Atropa belladonna*, deadly nightshade). You may feed them with belladonna for weeks without observing the least toxic symptoms. The meat of such animals, however, proves poisonous to any one who eats it, producing the same symptoms as the plant. Pigeons and various other herbivora are also to some degree safe from the effects of this poison, while in warm-blooded carnivora it causes paralysis and asphyxia. In frogs the effect is a different one, consisting of spasms. The meat of goats which had fed on hemlock has sometimes occasioned poisonous effects. Chickens are nearly hardy against nux vomica and the extremely dangerous alkaloid, strychnine, contained in it, while in the smallest amount it is a fatal poison to rodents. More remarkable yet in this respect is the immunity of *Choloepus Hoffmanni*, a kind of sloth, living on the island of Ceylon, which, when given ten grains of strychnine, was not much affected. Pigeons are possessed of high immunity from morphine, the chief alkaloid of opium, as well as from belladonna. Eight grains were required to kill a pigeon, not much less than the mortal dose for a man. Cats are extremely sensitive to foxglove (*Digitalis purpurea*), which on the contrary may be given to rabbits and various birds in pretty large doses. Many kinds of fish may be killed by just a trace of *Cocculus indicus*, although their meat is not made injurious by it. Laughing-gas, or nitrogen monoxide, a means used to relieve pain in light surgical operations, affects man more than any other creature; when breathed in a mixture of four parts of laughing-gas and one part of oxygen it produces a pleasant kind of intoxication together with diminished sensibility, though in animals no such effect has been observed.

The immunity of certain animals against the bite of venomous serpents is remarkable. Numerous observations have been recorded proving the polecat, hedgehog, and buzzard to be proof against the bite of the viper; it is mortal for most other animals of the same size and nearly related to them.

Immunity, however, is not limited to the relations of animals to poisons of vegetable or animal origin, but is manifested as well in conditions and processes in the healthy animal organism and in its susceptibility to diseases. The resistance offered by the living stomach of an animal to the dissolving effect of the juice secreted by the stomach itself has to be explained by immunity. A watery solution of pepsin—the digestive principle of the stomach—acidulated by muriatic acid, and thus, as to composition, corresponding to the digesting juice of living animals, upon addition of pieces of the stomach of any mammal, dissolves them, forming a perfect solution. The stomach of the living healthy animal, on the contrary, does not undergo the least change by the secreted juice; it is proof against the digesting effect of its own secretion, as well as to a certain degree against various sickening external influences.

Prominent naturalists are at present occupied in inquiring for a reasonable way of interpreting the causes of sickness and the conditions of immunity from it, or the resistance offered by a sound organism. Sickness, as well as health, according to one of the prevailing theories, depends upon chemical causes, viz., on the presence and predominance of various complex substances generated in the juices and tissues of the body by unknown processes, in which bacteria may sometimes play an important part. According to another theory, the living animal cells are engaged in a continual struggle against intruding micro-organisms. Animal cells are considered as individuals similar in character to the order of *Amœbæ*, which are unicellular organisms of the class of *Protozoa*. Metschnikoff found that certain cells of the animal body are endowed with the faculty of swallowing and digesting intruding bacteria of every kind, harmless ones as well as pathogenic ones, or such as produce disease. Not all elementary organs of the body are equally qualified for this purpose, the function being intrusted to certain cells of the tissues and blood, which Metschnikoff calls *phagocytes*. Health as well as disease depends upon which party is victorious in the struggle. Health is insured as long as the cells are capable of overpowering the intruding bacteria; an animal in such a condition is secure against disease. Experiments performed by Metschnikoff have given evidence that the bacilli of splenic fever are easily devoured and digested by phagocytes. On the other hand, several observers of late have maintained that the liquid part of blood, the plasma, and even common albumen, possess the faculty of killing bacteria. This, however, appears improbable, and a final decision of the question has still to be expected in future.

Susceptibility to diseases is as variable as sensitiveness to vegetable and animal poisons. Judging from the current opinion that putrefying animal matter is the principal bearer and transporter of infectious germs, we are forced to ascribe a high degree of immunity to certain animals which, like swine, ducks, chickens, and rats, are accustomed to select their food from places where such matter is accumulated. Predisposition for splenic fever is stronger among herbivora than among carnivora; birds of prey seem to be quite free from it. Experiments on sheep, performed by Pasteur, the results of which were confirmed by application on a large scale, gave evidence that immunity against splenic fever may be acquired by systematic inoculation of the attenuated virus very much as small-pox is prevented by vaccination.

Various herbivora, chiefly horses, sheep, and goats, are exposed to a disease called "glanders," which ends by death in most cases.

White mice are safe against it. This circumstance of late occasioned R. Koch to ascertain, by experiments, whether predisposition to glanders might not be artificially induced by changing the composition of the animal juices. The change consisted in the formation of sugar in the blood of the mice, which received as food *phloridzin*, a crystalline compound, naturally preformed in the roots of fruit trees and easily splitting up into sugar and some other products. It undergoes a similar change when brought into the circulation of the blood. The result of these experiments was, that white mice lose their immunity and become susceptible to glanders when phloridzin is given to them; infection by this disease invariably took place when the mice were inoculated to the virus, and thus the proof was furnished that by changing the chemical conditions of an animal its immunity from infectious disease may be neutralized. This indicates that immunity in the present case, as in the action of carbon monoxide, depends upon the composition of the blood, predisposition being established when the composition is changed.

These facts indicate that, as to susceptibility to and immunity from the effect of poisonous and virulent matter, the composition of blood is of the highest signification, and that the changes caused chiefly relate to its condition. They coincide with the experience that the action of poisons throughout is quickest and most energetic when they are injected into the blood; moreover, there seem to be many substances existing which induce infection only when present in the circulation of the blood, but not when brought into the digestive channel. Apparently harmless lesions can turn out disastrously, when even the smallest trace of a virus happens to reach the wound.

THE DECLINE OF RURAL NEW ENGLAND.

By Prof. AMOS N. CURRIER.

IN every period of American history the influence of New England has been marked and out of proportion to its size and population. In religious thought and activities, in great moral and social movements, in literature and scholarship, in inventive genius and the skilled industries, in the pulpit, at the bar, on the bench, and in legislative halls, New-Englanders have always stood in the front rank and have contributed largely to the worthiest American achievements.

Now, the bulk of this population, until very recent years, has been rural rather than urban, and the towns themselves, large and small, have been made up of the country-born and country-bred, while almost the entire stream of emigration that has flooded and fertilized the Northwest has had its source in the hamlets and farms. It would be easy to show that the quality of this output from the rural districts has been even more remarkable than the quantity. Hence came Webster, Choate, Chase, Greeley, Cushing, Bryant, Whittier, Beecher, Hopkins, and a long list of notables that will occur to every reader. It may therefore be fairly claimed that what New England has been and what it has done, at home and abroad, through its citizens or through its colonists, has come in large measure from the country districts.

Hence the prosperity of this region concerns not merely New England, but the country at large. The testimony of many reliable witnesses and my own observations, covering more than twenty years, convince me that the outlook for the future is very unsatisfactory.

1. Fifty years ago almost every farm was cultivated by the owner, who had every interest in its most careful tillage, in making permanent improvements, and in the care of buildings, fences, and woodland. Hired labor was the exception, for the large families were quite competent for all the farm-work, the indoor as well as the outdoor, with a surplus which went to the aid of less fortunate neighbors, and sent brains and muscle to the city or to the opening West. Not all farmers were equally industrious, frugal, and successful, but there was a large body of landed proprietors, homogeneous in race, substantially on an equality socially, and alike interested in the present and future welfare of the community. In this respect there has been a great change in the last twenty years, and one which is going on more rapidly every year. The land is passing into the hands of non-resident proprietors, by mortgage, by death of resident owner, by his removal to the village or manufacturing center, or his emigration to the West.

It is also held in fewer hands, not as a general thing to be managed and worked in large estates, but to be rented from year to year.

The new proprietor has bought the farm at a small price, as compared with its former valuation, and has no interest or pride in it or its management except as an investment. So in every township there is an increasing body of renters, as a class unreliable, unsuccessful, shifting, and shiftless. Their interest in the property and the community is temporary, their tillage such as they suppose will bring the largest immediate returns with the least care and labor. It goes without saying that such farms and all their appurtenances are in a state of chronic decline. These renters are often bankrupt farmers, or young men without the pluck and thrift to become farm-owners, the courage and push to go to the West, or the qualities in demand in the manufacturing towns.

In some towns is found an increasing element of Canadian French, good-natured, easy-going, thriftless people, living in a slipshod way from their labor when things go well, but, if sickness comes, or crops are short, or the winter long and hard, more or less dependent upon the poor-fund. This floating population, and especially its French element, is the bane of local and even State politics, especially in New Hampshire, for many of its voters are purchasable at least once at each election, and, as it holds the balance of power in many small towns, purchasers for both parties are rarely wanting, and prices rule high. I have personally known voters who openly counted their election wages an important item in the year's revenue. It will be readily believed that all public interests have suffered enormously by the substitution of such people for the thrifty, public-spirited farmers who preceded them. This French element is further objectionable in that it keeps itself aloof from the spirit of its adopted country, intact in language as well as religion, and has declared its purpose to change New England to New France.

2. Many farms are without resident cultivators, and in all probability will never again be homesteads. The New Hampshire Commissioner of Agriculture reports eight hundred and eighty-seven such farms, and these are only a small part. I know a district where eight contiguous farms have been thus abandoned, and, taking the farm on which the writer was born as the center, a circle with a radius of five miles would inclose twenty farms abandoned within the last few years.

Some of these have good buildings, stone fences, apple and sugar orchards, and all have made comfortable homes. On some of them a few acres of the best land are tilled, while the rest produces a lessening crop of hay or is used for pasture. The fine old orchards, uncared for, are wasting away, a lilac or a few rose-bushes struggling for life in the grass show the site of the old garden, the buildings are falling to decay, and homesteads that have fostered large and prosperous families for generations are a desolation and will soon be a wilderness. In some districts the old country roads are becoming impassable from the growth of bushes and the cessation of all repairs. An eminent New England judge told me last summer that public sentiment in these districts will not allow a jury to find damages against the authorities in case of injuries to travelers from such defective highways, on the ground that the diminished population can not keep them in repair.

The abandonment of this rough country and the transfer of its population to more fertile regions or more remunerative employments may be no financial loss to the nation, but it robs New England of a hardy yeomanry, with whom the love of natal soil and home and simple life has been almost a religion.

3. Not only is the area of cultivated land decreasing in this way, but the land-owners are sensibly narrowing their tillage. The land is growing poorer, partly from natural causes and partly from less careful working and the marked decrease in the amount of live stock kept upon it. The fact is, farming does not pay, especially if help must be hired to do a large part of the work.

The farmer finds himself the victim of all the evils of a protective tariff without its supposed benefits. The promised home market he has found to his cost, if not his ruin, is a delusion and a snare. If the manufacturing centers in his vicinity have raised the price of some of his products, they have advanced the cost of labor in a greater degree, and drawn to themselves the best brain and muscle from the farms. He is being heavily taxed for the benefit of the whole list of these assistant industries that rob him of his working force, while the competition, intensified by labor-saving machines suited to the large prairie farms of the West and stimulated by lavish gifts of land to settlers and subsidies to railroads, ruinously reduces the prices of his products in his natural home market. He buys Western flour and Western corn for his own consumption at a cheaper rate than he can produce them with hired labor, and by reason of the long winter is unable to compete with the West and South in cattle-raising for the Eastern markets at his door. Confining his attention to the few crops that, from their bulk or perishable nature, are not subject to the destructive competition of the West, the ordinary farmer merely lives and pays current expenses, while his less shrewd and careful neighbor falls behind each year, and sooner or later will be sold out of house and home.

Naturally, there is a decay of heart and hope that blights growth and prosperity. Many farms within a hundred miles of Boston and not five miles from excellent railroad facilities will not sell for the cost of the improvements. The New Hampshire Commissioner of Agriculture gives a long list of farms with "fairly comfortable buildings, at prices from two dollars to ten dollars per acre," and a shorter list at higher prices. The Vermont Commissioner gives a list at from three dollars to five dollars per acre, and nearer to railroad or village, with better buildings, five dollars to ten dollars—"all at no great distance from market and adapted to doing business." I know of the sale of such a farm of fifty acres, with fair buildings, well supplied with water and fuel, at fifty-two dollars. What a paradise for the Henry George theorists!

4. Outside of the large towns and business centers the popula-

tion is stationary or dwindling with greater or less rapidity, according as the district in question is more or less exclusively rural. Then the percentage of young people and children is much smaller than fifty years ago. The old-fashioned large families are the rare exception, and the young folks are early drawn away from the old homestead. In my native town the school districts have been reduced from twenty-one to eleven, and many of these enlarged districts have only a half or fourth the pupils of the original divisions. The real decline of the native stock is greater than the decrease in numbers would indicate, for there is a decided increase in the foreign element, which with all its virtues is not qualified to strengthen and perpetuate the old New England type of character and spirit. Nor is this state of things confined to a few obscure places among the mountains, for some of the historic towns founded by the Puritans are undergoing the same process of decline or change of population. Many of the large towns, deprived of the former stream of recruits from the country, are fast changing from Anglo-Saxon to Celtic and from Protestant to Catholic.

5. In the last thirty years the colleges have been strengthened in endowments and appliances, and are doing a better and wider work than formerly; the larger towns have excellent high schools, and the well-endowed academies are strong and well attended. But, with the rural districts far removed from these advantages, there is no provision for secondary education. The ungraded district school, with its brief school term, is the beginning and the end of local opportunities. The unendowed academies of forty years ago, then filled with young people, are dead and have left no successors. It is true, some young people resort to the high schools and endowed academies, but secondary education here is far less general than in the former time, while many are lost to the college and higher education whom a good local academy of the old type would stimulate to an extended course of study. In one of the most picturesque districts of New Hampshire is an endowed academy that thirty-five years ago had an annual attendance of more than four hundred, and sent to college each year thirty boys, to say nothing of a dozen girls as well and widely trained for whom no college opened its doors. The same school has less than one fourth the old number of students and graduates. It is fair to say that the decadence of this school is partly due to the larger advantages offered by better-equipped rivals, but the main cause of decline is the dearth of young people in its natural region of supply, and the diminished interest in higher education.

6. Many churches have dwindled into insignificance, or have been blotted out altogether, owing to deaths and removals, with no

corresponding additions. In scores of towns houses of worship are closed, to all appearance finally, or are used for non-religious purposes, while others are in the hands of Catholics, or are too far gone to decay for occupancy of any sort. In many towns enough church members in substantial doctrinal accord might be found to form one strong and influential church but for minor points of doctrine and practice, and so, divided, they live at a dying rate, of little consequence to their adherents or the community. The whole truth would not be told if it were not added that this religious desolation is also largely due to lack of sufficient interest on the part of members and outsiders to support church work and attend religious services. Not that the faith of the fathers is repudiated for newer or more liberal ideas, but that apathy on the whole subject is often the prevalent spirit. The home mission societies regard some of these towns in as much need of missionary work as the rudest frontier settlements.

7. I am told by persons who have spent their lives in these rural towns that there is a decline in public spirit, and a visible growing away from the pure democracy characteristic of primitive New England. For example, the old school district is no longer a body politic in New Hampshire. A town committee manages all school affairs.

All the statements of this paper are particularly applicable to the large extent of rougher hill country of New Hampshire, Vermont, Massachusetts, and Connecticut, but in a lesser degree and with various modifications, to other districts remote from large towns. It is possible that some of these conditions may be improved when industry and population are rearranged and adapted to the changed circumstances, but I can not escape the conviction that the decline is permanent. Even if the late movement to attract Swedish immigrants to these abandoned farms is successful, neither we nor our successors will see here again a rural community of the old type—keen, active, intelligent, sturdy, and independent, of strong moral and religious fiber, an unrivaled capacity for popular government, and an inborn and inbred taste for hard work, plain living, and high thinking.

A conception of the rate at which facilities of communication have been developed during the past two hundred years may be obtained from the statement that in the seventeenth century it required fifteen days to go by diligence from Paris to Marseilles; in 1782, the time had been shortened to eight days; in 1814, to five days, by mail-post; in 1840, to three days; and in 1889, to fourteen hours. In 1830, the voyage from Marseilles to Algiers occupied ninety-six hours; in 1857, forty-eight hours; in 1877, thirty-eight hours; in 1887, twenty-eight hours; in 1889, twenty-four hours; and it is expected to be accomplished, by two boats that are to be built, in twenty-two hours.

THE PRINCIPLES OF DECORATION.

By Prof. G. AITCHISON.*

WE have, in our cities, three things that are adverse to the embellishment of our lives: First, we live, as a rule, in hired houses. No one will ornament his house with that which is beautiful, permanent, and costly, if some one that he neither knows nor cares for will, after a few years, enjoy it, and that without paying one farthing as compensation for the outlay. Secondly, our clothes are not only ugly, but ignoble in form. Sculpture or statuary, when used to portray man in the costume worn in England, is impossible; the ablest sculptor can but turn out a scarecrow if he is bound to reproduce the actual clothes. Thirdly, in our buildings the atmosphere and its accompaniments almost forbid external color in monumental materials. Those materials that are unaffected by wet, frost, and the vitriol of the atmosphere, are soon covered with a pall of soot and dust. If we could once get Englishmen to love something beautiful, the fine arts might then enter on a new career. Our machinery and mechanical appliances could furnish almost the poorest houses with copies of first-rate works of art if the demand once arose. It is, however, much more important that the outsides of buildings should be enriched with color and lovely form than their insides. I may say that they are wanting in their first duty to the public if they are not beautiful, for they have not only taken some sky and air from us, and possibly flowers, trees, or herbage, but they help to poison the air by their smoke, dust, and exhalations.

In using decoration we are strictly following Nature, who not only makes the most of her works of beautiful form and of beautiful color, but enriches them with a variety of texture, of patterns, and of colors that would in man's work be most strictly decoration. No doubt some of this is protective, but much also, as far as we can judge, is purely ornamental.

The schemes for decoration are purely architectural, not only when they apply to buildings but also in the case of separate articles that are movable, and that are not wholly covered with one scheme of ornament, and for this reason, that architecture deals with harmonic proportions, and with the contrast of primitive forms.

What may be called formal ornament is the application of certain observed facts in Nature that please. Up to a certain point the repetition of some simple form is pleasing: lines are said

* Abridged from his lectures before the Society of Arts.

to be divided harmonically when they have certain ratios to one another, and spaces may have similar proportions, and these as well as certain curves give more pleasure than others; the combination of some flat and sharp curves is also found to be beautiful; the contrast of certain forms and of certain colors also gives pleasure. It is the application by man of these observations properly worked out to things he wants that makes them ornamental, and their superposition on elegant forms is said to decorate them. That which is the most perfect in ornament is the work of people gifted with high artistic fiber, and faultless execution, to whom Nature appeals in her masterpieces, who assimilate some of the matchless grace they see in a flower, in the turn of a leaf, in the curves that mark the growth of a creeper, in the wing of a bird, the curve of a lizard, or the knots or spirals of a serpent, who can so arrange these forms as to perfectly satisfy the cultivated eye, and keep them subordinated to the containing lines; such things may be seen in examples of Greek and Tuscan, or rather north Italian, ornament. This sort of ornament by some mishap has got christened *conventional*, a term which has no meaning as applied to ornament; it should rather be called *abstracted*.

Color is another species of ornament that, like form, has doubtless its laws, though as yet neither have been discovered, and we call form and color, like medicine, empirical arts. We observe that the collocation of certain spaces, or masses of certain colors, give us more pleasure than others, and we try and recollect these collocations if we deal in color, and use them when we have occasion. It has been observed that the primaries that are complementary—i. e., whose mixture produces white—go well together, and that certain secondaries and tertiaries set off primary colors. Chevreul found that the saturation of the eye with a color caused it to see the complementary color if a white surface was looked on; and Chevreul also found out that, if we looked at another color, it was modified by the complementary color of the first.

In choosing color we should be careful to have such a tone as we can live with, for most people have their dislikes and preferences. The color of a lady's boudoir is mostly chosen because it sets off her complexion. In a room where we work we are soon conscious of an objectionable color which irritates instead of soothing us. Certain colors and certain tones are beneficial or prejudicial to health. Very dark rooms are prejudicial, and red or yellow will also have a prejudicial effect on our health if we have to remain in rooms of either color all day and every day. A manufacturer had a women's workshop painted yellow, and found much more than the usual sickness among his hands. His doctor recommended whitewash, and the normal health was restored. Growers of hyacinths have noticed a marked effect on their blooming when they are put in glasses of certain colors.

This age is a peculiarly health-seeking one, and it does not seek health, as the Greeks did, by early rising, temperance, open-air exercise, and training; but it asks how health can be preserved and promoted by the removal of external sources of disease, so that it may have freedom to infringe with comparative impunity Nature's laws. External poisons are the most important things to protect ourselves from, especially when we have enfeebled our bodies, and these are mostly conveyed to us by mephitic vapors and what the doctors call septic dust. We want our houses and other buildings so constructed that they can be freed outside from their palls of dust and soot by means of a fire-engine or a sponge, and inside by the broom, the dusters, and the flannels of the housemaid.

Foul and poisonous air has scarcely any connection with decoration, but, with one or two exceptions, is in relation with pure science and its applications. The exceptions are when some of the materials used for decoration have a pernicious chemical action on the air, or parts of their substance readily come off and poison us when we breathe, or when in contact with our skin. The former is said to be the case when preparations of arsenic and some other dyes and pigments are used and are not varnished. The dust that is not septic consists of minute particles of raw or cooked earth, stone, and metal, and the ill effect it may produce can only be from irritation of the mucous surfaces, by clogging fine vessels, or by getting into parts where it is not wanted. Particles of some metals, if numerous enough, may poison us, as fire-gilders are poisoned by mercurial fumes. The septic dust consists of particles of vegetable or animal fiber, sometimes laden with the germs of disease, the pollen of flowers, by some of which hay fever is said to be produced, the eggs of microscopic creatures, and microscopic creatures themselves. Another source of poisoning is by animal and human exhalations.

Anything that forms a dust-trap is as far as possible to be avoided, particularly when these traps can only be partially emptied at long intervals, for every breath of air dislodges some of the lighter particles. The absorbents of the foul-smelling exhalations have also the property of imparting them to damp air, by which we are poisoned or repoisoned. Consequently we want to avoid as much as possible all woven and felted stuffs in our houses, and to have all wood and paper protected by varnish.

Few of us can expect to live in houses built of polished granite, porphyry, and jasper, and adorned with precious stones, but we may expect to live in those protected and embellished with enameled terra-cotta, glass slabs, or glass mosaic, and that our streets may at least present a clean, gay, and cheerful appearance.

I beg you to observe the Chinese, Japanese, and Persian pottery exhibited, mostly in the shape of tiles, and I ask you if these would not make a lovely alternative to our present fronts of dingy brick or plain or painted compo. When I was in Cairo, many house-fronts and some fronts of mosques were faced with these Persian or Rhodian tiles. If any one would start a gorgeous front of enameled pottery, there would be an outcry at first; but we should gradually get accustomed to beauty and color, and become reconciled to the loss of dingy and blackened brick. Even now there is no outcry when the platforms of a railway station are lined with white glazed bricks banded with green or gray, and the small extra cost would soon be repaid by better health and the saving of painting. At first this could only be done by tasteful, benevolent, and patriotic men who were wealthy, or by enterprising ones, who thought a house so fronted would advertise itself; but as this sort of facing came into fashion, window jambs and reveals, panels, strings, and cornices would be kept in stock, probably printed in colors instead of hand-painted, and would be cheap enough. There is one use of enameled pottery I have not mentioned—roofing tiles. In parts of France and Italy these prevail. At Lugo, in the Romagna, I saw the steeple of a church covered with enameled pottery of different colors, which wound round it, the steeple being a cone; the visible glazed parts were semicircular in section, and, though I do not know how they were fixed, they looked as if they were stuck into mortar, like the enameled terra-cotta cones found at Babylon, and used to ornament wall surfaces. Most of the tile patterns I have seen in France are, to say the least, more ingenious than beautiful; but there are gold and green tiles used at Vienna and at Botzen that are ornamental enough.

Even the Romans were more alive to the use that might be made of broken glass than we are, for we learn from Martial that the collection of broken glass was a trade, and the glass, he says, was exchanged for brimstone matches. I can not say how these glass slabs or tiles would stand our climate, but, if they could be fixed in no other way, they might be set in frames of cast iron, barffed.

I hardly know if I should include *sgraffito*. It would certainly be useless in the denser parts of London, as it would soon be a uniform dingy black; but we know that there are still examples that are visible at South Kensington, and that it lasts well in the country. It is done in this way: Any colored ground that may be chosen is first prepared of mortar or cement, colored with earthy or mineral pigments; it is then laid on the wall.

White, black, yellow, red, or gray are the usual colors. On one of these grounds, before it is dry, about one eighth of an inch of cement of one of the other colors is laid, the pattern is pounced on, and the parts outside the pouncing are scraped off with a modeling-tool, a knife, or a bit of stick. When the whole has set, you have a picture or a pattern in two colors. This sort of work has stood in England for over twenty years when executed in the country, and in Italy the whole fronts of many large palaces have been adorned in this way, and have stood for centuries.

Public buildings built of polished marble, granite, porphyry, jasper, agate, or onyx, or faced with these, are sometimes ornamented by inlaying pictures or patterns with colored marble or precious stones; but I do not know of any external example in England. This work is called *pietra dura*. The Taj Mahal in India is a celebrated example. There are plenty of slabs, basins, vases, paper-weights, and jewelry imported from India and Italy of *pietra dura* work.

All external work in calcareous marbles soon perishes in the atmosphere of London, whether plain or inlaid, and all incised work filled with mastic so soon gets blackened that to execute it is merely labor lost. The only other work that can be used externally is in metal. Iron rusts unless constantly painted, and almost all other metals turn black. Real block-tin, not tinned iron, is said to stand the climate of London, but of course does not lack its pall of soot. Iron plates tinned are much used in Switzerland for the covering of steeples, but even there they get rusty. Lead takes its own blackish gray, but, as it otherwise stands the climate well, I wonder it is not more used for ornamental purposes, as vases, statues, roof-crestings, and the like. When I was a boy, some plumbers' shops were ornamented with leaden statues, vases, and ornamental cistern fronts. Lead is still used for ornamental roof-crestings in France, often heightened by gold, black varnish, and color. Lead is still much used for ornamental accessories in Holland—or perhaps I ought to say, was once used. Up to a short time ago there were leaden statues and vases in the gardens of the stately mansions in Mark Lane, near the Tower of London; there are still some at Hampton Court, and they would do very well in the niches or on the pedestals of our red brick fronts, if we could not afford bronze.

It is unnecessary to speak of the ordinary freestones that weather in London, the sandstones, the brick, both cut and moulded, the red, yellow, or gray terra-cotta, for all these have more or less granulated surfaces that can only be cleaned by tooling or rubbing, but plaster has never of late, as far as I know, been even tried—I mean plaster of common sand and lime, or, what is still better, of lime and marble-dust. Vitruvius tells us that old Roman walls covered with this material were so hard, so beautiful, and so finely polished, that in his time slabs of it were cut out and used for table-tops. In speaking of plaster, I did not mean compo, either Roman, Portland, or mastic, but that plaster that is made workable for modeling, which the Italians call *gesso duro*. It was once common in England; the "Peter Pindar," in Bishopsgate, is an example, or was an example a few years ago, and many admirable specimens still exist in our country towns. Some of the vaulted ceilings of Hadrian's villa, at Tivoli, now open to the air, are still adorned with it, the grace, freedom, and delicacy of whose modeling we still admire, although it was done at least seventeen hundred years ago. In few things has England declined more than in plastering, from the prevalence of casting, which allows the employment of the least skilled mechanic. Most of us have seen the magnificent ceilings of Elizabeth, James, and Charles I's time, on whose flowers, fruit, etc., you can even now see the grain of the plasterer's hand, and the holes made by his thumb to get shadow. Even in plastered ceilings of Sir W. Chambers's time, who died in 1796, you see beautiful work in high relief of fruit, flowers, and foliage, and I believe the skill did not die out completely till the end of the first quarter of this century. The infinite variety that hand-stamping produces would to refined tastes be worth the expense, for cast work is all alike.

It is highly benevolent to encourage skilled handwork, for you not only liberate the better sort from that mechanical work which frets and eventually destroys a man by its unvarying and unthinking monotony, but you encourage higher skill, and you allow a man to put his soul instead of his fingers into the work.

Do not suppose I am finding fault with those excellent materials, Roman and Portland cement, or even mastic; all I mean is that, as yet, we have found no way of using them ornamentally in London, except as imitation of stone and stone carving. If we had a pure atmosphere, the first two would be invaluable for inlaying, but in a very short time stone and inlay are indistinguishable from the general grime, and that, too, even when the inlay is black mastic.

In the present day, most of our internal plaster-work of any pretension is done in canvas plaster. A thin coat of fine plaster of Paris is brushed into the mold, very thin open canvas in strips is pressed into this, and brushed over with coarse stuff; the whole is then stiffened with slips of wood, attached to the backing with canvas and plaster; it is then dried in a hot room, and screwed up in its place, and can be painted on at once; its greatest merit is its lightness. The defects of canvas plaster are its want of flatness in the larger panels and of straightness in the cornices.

Bronze, though it becomes a blackish green, has this advantage for the decoration of buildings, that it can be reproduced as often as you please from the modeled clay of the statuary. You may, therefore, get through its means first-rate work at low cost, if the repetition is great, and its use may be called benevolent as well, for it does not condemn skillful men to the brainless work of constantly reproducing the same thing.

It is needless to speak of wrought iron, which can be made into any form you like, and of any size and thickness, from the stem of an anchor to a leaf, and chased or engraved, polished or lacquered, tinned or gilt. I am happy to say that wrought-iron work is receiving great attention again both from architects, painters, and iron-workers, and can be made nearly as well as it ever could. I think cast iron has been needlessly depreciated and needlessly neglected in this truly iron age. You can not get the fineness of bronze, and you can not chase it, but you can get really beautiful work done in it, and the wit of man can never be better employed than in using good materials at hand in the proper way—i. e., by only asking them to do what they can do readily and properly. As far as I know, the only real drawback to cast iron is its liability to rust. If Mr. Barff's process can be applied cheaply and will resist the attacks of the atmosphere for a long time, all we have to put up with is blackness, and, if the parts of a front we must have blank were filled in with glass slabs, you need have very little more black than you want.

Cast iron is a difficult material to use—I mean it wants to be calculated for its strength, it requires much thought to ornament, and everything, even to a bolt-hole, has to be settled beforehand, and, except there is much repetition, it is costly. Its neglect is greatly owing to this, that no one will pay for the extra skill, time, and trouble required of the architect, so this admirable material is almost ignored.

As regards marble, I can not quite agree with M. Charles Garnier, that "even when it has lost its polish it still looks like a shabby gentleman, and is not to be mistaken for a vulgar fellow in his Sunday clothes." Except in rainy weather, when the marble is temporarily polished by the wet, its unpolished surface, in my opinion, can not be regarded as worth the outlay; and I say this with hesitation and regret, for the exquisite harmonies produced by the decayed marble of St. Mark's was a thing to be remembered; still, as an architect, I can not reconcile myself to using a precious material merely to give a flavor when I know that, in giving it, it is going to decay; I might, perhaps, if I were a painter. But for the inside of a building marble is the richest material you have for the production of lovely color—music without words—painted as it is by Nature's hand, with every tint and tone of delicacy and subtleness, and enlivened, too, by the wildest caprices of beauty.

The bar to its use in England is the damp, for when the air is full of vapor the marble condenses the moisture, which stands on it in drops or trickles down it. But as most houses and buildings are now warmed, this need not stand for much, and if we panel our rooms below with wood, there is no reason why the upper part should not be of marble. Marbles are of every hue except blue, for blue Belge is black and white, and blue Napoleon, or imperial, is but bluish gray; and brown is scarce, though we have rosewood marble and Californian spar. Marbles are found in most countries of the world, and there are such vast varieties in Europe that they can hardly be catalogued.

Great taste in color is requisite for the proper arrangement of colored marbles; at present no one cares to exercise this taste as a profession, as there is so little effective demand, and, in spite of the low tone of marble generally, it is much easier to make a vulgar or discordant arrangement than a strikingly good or harmonious one. The fashion of using white marble chimney-pieces, white marble bas-reliefs, white marble statues and busts in decorated apartments, is absolutely fatal to low-toned schemes of color decoration, and, as a rule, all gorgeous schemes of color are low-toned, and white must then be used most sparingly as a jewel. White can only be sparingly ornamented with morsels of full color, or very high-toned decoration must be used in conjunction with it, as this alone can sustain masses of white.

Considering the wealth of this country, which mainly goes in useless feasting, useless men and maid servants, useless carriages and horses, and hideous as well as useless clothes, I do not think those who will not use marble from poorness of spirit are included in the beatitudes.

As I am now on marbles, I may as well include mosaic pavements. These must be greatly restricted in so cold and damp a place as England. Few of us love to walk on a marble floor without shoes or stockings, as all would do in a warm or hot climate, but it can be used for the pavement of Protestant cathedrals, for hall floors, for the center aisles of churches, for conservatories, porches, terraces, and the like; and when we can afford it, porphyry is by far the best material for the patterns, as it only polishes by the friction of dusty boots, unlike marble, which roughens, and unpolished marble is not more attractive than stone. Plain geometrical and flat floral patterns are the best, in marble or pottery floor mosaic, for the smallness of the pieces rather helps the scale of the room or building, and does not ruin it like marble squares.

The objection to pottery as mosaic in floors is its softness, so that it soon wears away under much traffic. Figure-pictures, for a floor to be walked on, are a mistake, though they may be used as a center-piece to be looked at from above, and be surrounded by plants or flowers; but nothing can be more appropriate for internal wall decoration than figure-subjects, or floral ornament in marble or tile mosaic; in either case it is permanent, and can be easily cleaned, and that in marble, at least, must be low in tone, for it can have but two colors of complete purity, white and black.

England has got rich these last sixty years by flooding the world with rubbish, so nothing can be more patriotic than having a piece of the best workmanship you can obtain put in your house, and by that I mean attached to the freehold, if it be your own, and let this piece be adorned by the hand of an artist, for his workmanship is transcendental, and, if possible, let it portray a noble example, or evoke a noble reminiscence, and be of such materials that it can not well be sold or destroyed for the value of the material.

SKETCH OF ELISHA MITCHELL.

A MONUMENT of modest size and style, standing, in Yancey County, North Carolina, on the highest point of land in the eastern United States, marks the grave of the man who first determined, by measurement, the culminating point of the Appalachian range—a man, too, whose local fame as a student of natural history, a hardy explorer, and a teacher, was pre-eminent. Not the little obelisk of bronze—that only shows the exact spot where his body lies—but the mountain on which it stands, whose supremacy over all the peaks east of the Rocky Mountains he established, and in the exploration of which he lost his life, is the true monument of Prof. Elisha Mitchell.

ELISHA MITCHELL was born in Washington, Conn., August 19, 1793. His father, Abner Mitchell, was a farmer; and his mother, Phebe Eliot, was a descendant, in the fifth generation, from John Eliot, the Apostle to the Indians. His great-grandfather, the Rev. Jared Eliot, M. D. and D. D., for many years minister at Killingworth, Conn., was distinguished for his knowledge of history, natural philosophy, botany, and mineralogy, no less than as a sturdily orthodox theologian; was a correspondent of Dr. Franklin and Bishop Berkeley, and was awarded a gold medal by the Royal Society for a discovery in the manufacture of iron. Young Mitchell inherited many of the qualities of the Eliots, and particularly of this ancestor. At four years of age he acquitted himself with credit in a school exhibition. At a little later age he was fond of collecting his playmates in a group and telling them what he had read in his books, or explaining the pictures to them. He was prepared for college at the classical school, in Bethlem, of the Rev. Azel Backus, D. D., afterward President of Hamilton College. He was graduated from Yale College in 1813, in the same class with Denison Olmsted, afterward his associate in the University of North Carolina, and with other persons who subsequently became conspicuously known. He was then engaged as a teacher in Dr. Eigenbrodt's boys' school at Jamaica, L. I.; in the spring of 1815 he took charge of a school for girls at New London, Conn., where he became acquainted with the lady who was afterward his wife; and in 1816 he was appointed a tutor in Yale College. While thus engaged, he and Prof. Olmsted were recommended by the Rev. Sereno E. Dwight, son of President Dwight, Chaplain of the United States Senate, to Judge Gaston, member of the House of Representatives from North Carolina, who appears to have been looking around for candidates as suitable persons for professorships in the University of North Carolina, at Chapel Hill. Mr. Mitchell was chosen Professor of Mathematics, and Mr. Olmsted Professor of Chemistry, to which a chair was then for the first time assigned. Having studied for a short time at Andover Theological Seminary and received a license to preach, Mr. Mitchell removed to North Carolina, and reaching Chapel Hill on the last day of January, 1818, immediately began his work as a professor. Here he remained, continuing at his post without intermission of considerable length, for thirty-nine years, or till the end of his life.

In the fall of the next year Prof. Mitchell returned to Connecticut to be married to Miss Maria S. North, daughter of Elisha North, M. D., of New London. The bride's letters describing her journey to North Carolina give some side-lights on the life and methods of travel of the time. The marriage took place on Friday, the choice of the day having been partly made as a demonstration against a popular superstition, and partly determined by circumstances. The journey of eight hundred and fifteen miles to Chapel Hill occupied ten days. On the removal of Prof. Olmsted in 1825 to accept a professorship in Yale College, Prof. Mitchell was transferred to the chair he had filled, and became, and continued till the end of his life, Professor of Chemistry, Mineralogy, and Geology.

Dr. Albert R. Ledoux, in a historical sketch of the University of North Carolina, published in the University Magazine for October, 1890, speaking of the intellectual giants in its faculty who have given reputation to the institution, and whose contributions to letters and science made them prominent among the learned men of their day, observes that Prof. Mitchell was the most noted of them all. During his occupation of the chair of Mathematics, the doctrine of fluxions, or the calculus, was introduced into the course, and the standard of attainment was raised in other branches of the department. His transfer to the chair of Natural Science was welcome to him. Even while a Professor of Mathematics, according to Prof. Charles Phillips, he had made frequent botanical excursions in the country round Chapel Hill; and after settling himself in his new chair he extended and multiplied these excursions; "so that when he died he was known in almost every part of North Carolina, and he left no one behind him better acquainted with its mountains, valleys, and plains; its birds, beasts, bugs, fishes, and shells; its trees, flowers, vines, and mosses; its rocks, stones, sands, clays, and marls. Although in Silliman's Journal, and in other periodicals less prominent, but circulating more widely nearer home, he published many of his discoveries concerning North Carolina, yet it is to be regretted that he did not print more and in a more permanent form. It would doubtless have thus appeared that he knew, and perhaps justly estimated the worth of, many facts which much later investigators have proclaimed as their own remarkable discoveries. But the information that he gathered was for his own enjoyment and for the instruction of his pupils. On these he lavished, to their utmost capacity for reception, the knowledge that he had gathered by his widely extended observations, and had stored up mainly in the recesses of his own singularly retentive memory." The notes of his excursions, which are recorded in a series of blank books kept for the purpose, give revelations of the habits of the author's mind; they chronicle his walks over farms which he names, and observations of individual plants and other objects in specified localities. "By such a rock," writes Mrs. C. P. Spencer, in an article of reminiscences, "in such a field, is a plant that he must identify. By Scott's Hole, near the willow is a *Carex* that he must watch. March 29, 1821, he finds yellow jessamine in bloom in Mrs. Hooper's garden, and 'in great abundance on the creek below Merritt's mill.' . . . May 30, 1821, occurs this note, that he had that day found the last of the twelve varieties of oak that are within two miles of the university; then follows a list of the oaks and notes of their situation. . . . In the third week of April, 1824, he begins a new Diary of Mosses, and hunts the *Liskea hypnum* through a dozen authorities, to be sure of it. He had the true scholar's disdain of taking anything at second hand. Such pages are diversified with 'Hints for the good instruction of the class'; or, 'Points to be meditated respecting the nature of light.'" In the preface to one of these note-books—written in French—a plan of study was laid down for each week. So many hours were to be given to mathematics, so many to Latin and Greek, so many to history, so many to the Spanish language and to botany; and the resolution appears that, till such an hour, "I will not touch one book of *belles-lettres*." He thus visited the plants and rocks of the State in their own homes, and became one of the best authorities in the country respecting them. The expeditions which he conducted into all parts of North Carolina, examining the flora and rocks and strata, made him the best physical geographer the State had ever had. The information he gathered in this way was used profusely in the instruction of his classes, and they always reaped greater benefits from his acquisitions, than any other part of the community. While he wrote occasionally for the scientific papers, "he read more than he observed, and observed more than he wrote." Among the articles contributed by him to Silliman's Journal are named, in a memoir published in the local paper at the time of his death, those on the low country of North Carolina, 1828; on the Geology of the Gold Regions of North Carolina, 1829; on Welther's tube of safety, with notices of other subjects, 1830; on the causes of winds and storms, 1831; Analysis of the Protogæa of Leibnitz, 1831; and notices of the high mountains in North Carolina, 1839. Such articles were contributed at intervals till the time of his death. He also prepared for use in his classes, a Manual of Chemistry, the second edition of which was passing through the press when he died; a Manual of Geology, illustrated by a geological map of North Carolina; and Facts and Dates respecting the History, Geography, etc., of Palestine.

Prof. Mitchell was an industrious reader, particularly on all subjects that were directly or indirectly connected with his professorship, and had a knowledge of geography that was regarded as wonderful. At a time when students were more isolated from one another than they are now, and facilities for exchange of news were not so abundant, he was at great pains to keep up with the advance on every side. With all this he was of conservative tendency, and not disposed to accept the new too hastily. As a teacher, Prof. Phillips says, "he took great pains in inculcating the first principles of science. These he set forth distinctly in the very beginning of his instructions, and he never let his pupils lose sight of them. When brilliant and complicated phenomena were presented for their contemplation, he sought not to excite their wonder or magnify himself in their eyes as a man of surprising acquirements, or as a most dexterous manipulator, but to exhibit such instances as most clearly set forth fundamental laws, and demanded the exercise of a skillful analysis. Naturally of a cautious disposition, such had been his own experience, and so large was his aquaintance with the experience of others, that he was not easily excited when others announced unexpected discoveries among the laws and the phenomena which he had been studying for years as they appeared. While others were busy in prophesying revolutions in social or political economy, he was quietly awaiting the decisions of experience. He constantly taught his pupils that there were things wherein they must turn from the voice of the charmer, charm he ever so sweetly. His influence on the developments of science was eminently conservative, for he loved the old landmarks."

Prof. Mitchell's general fame rests chiefly on his work in the exploration of the Black Mountain of North Carolina, a spur which, standing between the main mountain ridges, had been regarded by persons best acquainted with the region, without knowing its exact height, as the culminating point of the Appalachian system. The two Michauxes had remarked, about the beginning of the century—the elder in 1799, and the younger in 1802—the presence of Alpine plants there that were not found again south of Canada, and inferred that the peak must therefore surpass all its fellows in height. John C. Calhoun had come to a similar conclusion, from the observation of the streams that had their source on the mountain. Meeting the Hon. David L. Swain, who was afterward President of the university, in 1825, Mr. Calhoun congratulated him on being of the same height with Washington and himself, and on their both residing in the neighborhood of the highest mountain on the continent east of the Rocky Mountains. When asked the meaning of his remark, Mr. Calhoun referred to the map as showing that in this group were to be found the highest sources of one of the great tributaries of the Mississippi, the Tennessee; of the Kanawha, flowing northward into the Ohio; and of the Santee and Pedee, which run directly to the Atlantic—all considerable rivers finding their way to the sea in opposite directions. The story was told by Governor Swain to Prof. Mitchell in 1830, during an excursion on the Cape Fear River. Although Mr. Calhoun's reasoning was defective, his observation, coupled with the opinion expressed on other grounds by the Michauxes, impressed Prof. Mitchell, and aroused a desire in him to know more of the Black Mountain, and to determine its height. The opportunity came in 1835. The memorandum-book in which the notes of his visit in that year are recorded contains such entries as "Objects of Attention—Geology; Botany; Height of the Mountains; Positions by Trigonometry; Woods, as the Fir, Spruce, Magnolia, Birch; Fish, especially Trout; Springs; Biography"; etc. He was accompanied by his daughter, and carried "two barometers, a quadrant, a vasculum for plants, and a hammer for rocks." The incidents of this expedition, the details of which became important in the case of a controversy that afterward arose, have been summarized and confirmed by the testimony of witnesses in an article which Prof. Charles Phillips contributed to the North Carolina University Magazine for March, 1858. Having made some observations of the geological formations of the Grandfather Mountain, and measured some heights near Morganton, Prof. Mitchell crossed the Blue Ridge and fixed his headquarters at Bakersville, in Yancey County, near the foot of Roan Mountain. Hence he made several excursions in a country which was then nearly in the condition of the primitive wilderness. Being told that Yeates's Mountain was the highest of the group, he climbed it, accompanied by two guides, on the 27th of July, 1835—a day so clear and serene "that all the main eminences of the Black were clearly visible." He found that this mountain was overtopped by several of the peaks around it, the most of which confronted him in an arc so curved that it was easy to decide which of them was the highest. He made the entry: "Top of Yeates's knob; N. E. knob of Black bore N. 46¾ E. Counting from Young's knob: one low one; one low one; two in one, the southernmost pointed; a round knob, same height; a double knob; then the highest; then a long, low place with a knob in it; then a round three-knobby knob, equal to the highest, after which the ridge descends." This verbal account tallies exactly with a profile of the range drawn by Prof. Guyot when standing on the same Yeates's Peak in 1856. On the next day, July 28th, Prof. Mitchell and his guides visited the peak which had been determined by the Yeates's Mountain observation to be the highest; according to the testimony of the guide, William Wilson, they "came to the top at a small glade, not more than a quarter of an acre in extent, and, turning to the right, not more than one hundred and fifty yards, we arrived on the top of the main highest peak, being the same one as we thought that we had selected from Yeates's knob the day before. Then Dr. Mitchell climbed into the highest balsam he could find, and took his observations. After consulting his barometer, he said that it was the highest point that he had found yet."

Some of the immediate results of the excursions from Bakersville, including geological and botanical observations, were published in the Raleigh Register of November 3, 1835. The height of the mountain was calculated as compared with that of Morganton, which was then supposed to be 968 feet above the sea. The mountain being found to be 5,508 feet above that point, its height was given as 6,476 feet, or 200 feet less than the real height. The discrepancy became afterward a source of confusion, and has been used to support the allegation that the peak Dr. Mitchell climbed that day was not the real highest peak. But it was explained and vanished when the railroad surveys showed that Morganton depot is really 1,169 feet high. This would make Prof. Mitchell's real measurement 6,677 feet, nearly what he obtained (6,672 feet) in 1844. Prof. Guyot, in 1856, obtained a height of 6,701 feet.

Doubts afterward rose in Prof. Mitchell's mind whether the peak he climbed in 1835 was the true summit of the mountain. A new measurement of Mount Washington had been made, which seemed to add to its reported height and lift it above Mitchell's Peak. Dr. Mitchell revisited the mountain in 1838, and determined in 1844 to make a new survey and measurement. He obtained a Gay Lussac mountain barometer from Paris, took William Riddle as his guide, and, making Asheville his base for comparison, found the height 6,672 feet. The identity of the peak visited this time was afterward called in question by other parties, but Prof. Mitchell himself never doubted that he had been on the right spot. He wrote in the summer of 1856, "I stood upon the highest peak some days since, and could then distinguish the ridges over which my guide, William Riddle, taking as nearly as he could a straight, or, as it happened, a diagonal direction across them from the neighborhood of the Green Ponds, led me directly to the peak we were in search of."

After the survey of 1844, the Hon. Thomas L. Clingman put forth a claim to having been the first to measure the real culminating point of the Black Mountain, and undertook to prove that Prof. Mitchell had been mistaken in the mountain which he measured. The question thus raised was the subject of an active controversy for several years. The highest mountain was called Clingman's Peak, and Prof. Mitchell's name was transferred to the peak which was described in his diary of 1835 as "a round three-knobby knob, equal to the highest," which he had never assumed to climb or to measure. It was as much to settle this dispute as for the sake of more accurate measurement that Prof. Mitchell made his fifth visit to the mountain in 1857, in which he lost his life. The question was investigated by his friends after his death, when all the accessible evidence was collected and compared, and his priority in measuring the peak, and the identity of the mountain he measured in 1835 with the real highest point, seem to have been satisfactorily established. In evidence to support his claim, Prof. Phillips brought forward the notes in his diary of 1835 and their exact correspondence with Prof. Guyot's profile; the testimony of William Wilson, one of the guides who went up with him, and who gave in his certificate a correct description of the topography of the summit, and of Nathaniel Allen, son of Adoniram Allen, the other guide, deceased, who said that his father had always spoken of that peak as the one which he ascended with Prof. Mitchell; the certificate of four citizens who accompanied William Wilson in September, 1857, while he retraced the steps of the ascent of 1835; the testimony of numerous citizens respecting the landmarks and the geographical features, particularly of the streams, by which the true highest peak is located and identified; and the testimony of the same citizens that this peak was generally known through the country as Mount Mitchell or Mitchell's High Peak, while the other mountain (Party Knob) to which Prof. Mitchell's name has been attached was not so known till after the visit of 1844.

Prof. Mitchell's fifth visit to the Black Mountain, in 1857, was made in view of the controversy with Dr. Clingman for the sake of obtaining more careful and accurate measurements than he had been able to secure before, and for the purpose of investigating the value of the number which is used in calculating heights by barometrical observations. To this end he had provided himself with four of Green's Smithsonian barometers, and sent one of them to Savannah to be employed in contemporaneous observations by Dr. Posey at the level of the ocean and nearly on the same meridian as the Black Mountain. He further intended to connect the beach-mark on the North Carolina Western Railroad survey by a line determined by a spirit-level with the top of Mitchell's Peak. After marking off points differing in height by five hundred or a thousand feet, he designed to continue contemporaneous barometrical and thermometrical observations for several days at each of these points, and thus obtain reliable data for a full discussion of questions concerning measurements by barometer in the latitude of the region. He began the survey about the middle of June. On the 27th of that month, when his work was about half completed, he separated from his son, with the intention of going across the mountain to the Caney River settlement to visit the Wilsons and Mr. Riddle, his former guides, and securing their assistance in identifying points which they had visited together. He was never seen alive afterward. A storm arose that evening, in which he probably perished. When it was found that he had neither reached Mr. Wilson's nor returned to his lodgings, parties started in search of him. As the search continued, and the news spread that he was missing, the parties grew, and soon included a considerable part of the mountain population of Yancey and Buncombe Counties; for the people were all warmly attached to him. His trail was found and followed to a point where the guides declared, from its irregularities and the evidences that the wanderer had become no longer able to pick his course, that darkness had overtaken him; thence along a small creek to a place now called Mitchell's Falls; and there, on the 7th of July, the body was found in the pool below the falls. The marks on the bank showed that Prof. Mitchell had slipped forty-five feet down the slope and then fallen fifteen feet into the pool. The body was borne by the Yancey men, after the coroner's inquest, a distance of about three miles, to the top of the mountain. Then word came that it was to be taken to Asheville; and the men of Buncombe took it up and carried it there.

Not quite a year afterward, in June, 1858, the body was exhumed from the graveyard of the Presbyterian church in Asheville, and was carried again, this time with formal ceremonies, and a procession of citizens, large considering the character of the march, to the top of the mountain, where it was laid in the earth, within a few feet of the famous balsam tree. A funeral discourse was pronounced by Bishop James H. Otey, D. D., of Tennessee, one of Prof. Mitchell's first pupils, and an address in vindication of Prof. Mitchell's claims to have the mountain named after him was delivered by President Swain. It is worthy of remark that the first class taught by Prof. Mitchell in the university was represented at the ceremonies, in the persons of Bishop Otey and Dr. Thomas H. Wright, of Wilmington, and the last class by Mr. J. W. Graham and his own son. A monument, twelve feet high, in the material known as white bronze, was erected over the grave in 1888.

The question of the name of the mountain appears to have been decided by the United States Geological Survey in 1881–'82, which, adopting the final designations for the peaks of this range, gave Prof. Mitchell's name to this one.

Prof. Mitchell was a Presbyterian minister of the Presbytery of Orange, Synod of North Carolina, and was styled, in the memorial resolutions passed by the synod, probably the most learned man that had ever lived in the State; was a regular preacher in the college chapel and the village church; and was the college bursar, a justice of the peace, a farmer, a commissioner for the village of Chapel Hill, and at times its magistrate of police. He was known as a skillful and conscientious professor, and vigilant, long-suffering, firm, and mild as a disciplinarian. Believing that prevention of the ills of a college life was better than having to cure them, he was watchful to guard the students against falling into error. When offenses were committed, he would try to present the nature of his conduct to the culprit in its true light, and, when punishment had to be inflicted, to select such a method as would appeal to his better feelings and open the way to a return to sound views. He loved to help others, and he was a well-grounded believer in revelation. He was extensively known among the mountaineers, who all had a remarkably warm affection for him, and the interest that was aroused among them by the circumstances of his disappearance was still "warmly alive," and the event was still a topic of conversation among them, as late as the end of 1889.

CORRESPONDENCE.

INDIVIDUAL ECONOMICS.

Editor Popular Science Monthly:

IT has been again and again stated, by good authorities, that the American people are the most wasteful upon the face of the earth; they do not utilize to any extent their health, strength, money, or talents. To any thoughtful mind there is evidence of this on every hand.

We might naturally suppose that our many excellent modes of teaching, from pulpit and teacher's desk, would eradicate this evil; but, on the contrary, the accessories of our churches and schools become more extravagant every year, and there is less to be hoped from them. There are many ill-balanced minds among the youth attending our schools. These, with their intellectual tastes aroused, leave school very poorly equipped to battle with the exigencies of modern life; consequently, many of our so-called educated youth become stranded as embezzlers in State prisons or patients in insane asylums.

When we study the causes which lead to the great amount of wretchedness, poverty, and crime in our land, it is evident that good effects would result to our people if every child could be taught to see the wisdom of properly economizing health, strength, money, and talents. In order to do this, public opinion must first be converted. People must realize that such men as George Bancroft, the historian; Robert C. Winthrop, the statesman; and William W. Corcoran, the philanthropist, and other noble octogenarians, could never have attained their great age and to such positions of honor among their fellow-men save by great self-denial and economy. To be sure, the law of heredity comes in to aid some persons; but do you not think, if the principles prevailed which governed the early life of Whittier and the frugal homes of New England, that each succeeding generation would reach a higher plane in social life? We expect certain intellectual results from public-school methods; why not expect moral benefits to the child's character as well? There are many teachers who strive for this, like wise Mark Hopkins; but the field of education is so extensive, and the attention of educators is so absorbed in other matters, that little attention is given to individual economics. Do not understand me to desire the inculcation of penuriousness among our young people, but simply wisdom and moderation in all our affairs. It has been customary at some boarding schools to have printed upon the plates from which the pupils eat such sentences as "Waste not, want not." Such are not the means that I would urge for teaching economy, but that our leaders in society, on the press, in the pulpit, and all teachers, should unite to enforce the great principles of economy and moderation by example and throughout all their teachings. Even teachers of natural history can bring their instruction to bear upon this point, from the innumerable instances of economy in nature.

When a colored girl in Washington replied to a reprimand for being late at school that the cook was absent and her mother was sick, and of course *she* could not get the breakfast, it showed the lack of thrift and right management in that household. She would have been ashamed to make that reply if the influence of her home and her school had not left her blind to the dignity of labor and the honor to be derived from doing one's duty.

We very well know that college life is the hot-bed of extravagance, and that no great and united effort has been made to repress this wasteful tendency. It is to be hoped that when our great institutions of learning have become financially endowed so that they are perfectly independent, they may be able to take some means to turn the tide and set a fashion of economy and moderation.

Investigation shows that our poorest classes are the most extravagant. On market-days we find that those persons who carry their entire fortunes in their hands will purchase the highest-priced provisions, which are often the least nourishing. If we could have savings-banks in our schools, as in England, our people who earn good wages could learn to accumulate. Millionaires tell us that it is the first thousand dollars which is the hardest to earn—interest then increases of itself. Have we not all had the experience of helping people who would not help themselves, but would, by lack of self-denial or even moderation, keep open some leak by which their misfortunes were continually on the increase?

Would there be so much temptation to anarchism and crime if our working classes understood the right principles of living?—if they understood that fortune and success are generally to be obtained only through systematic living and often great self-denial?

It is probable that our workingmen would not spend so much time and money in restaurants if they could obtain well-cooked food at home; therefore, cooking schools are a great help to economy.

That early training in thrift and moderation is much needed by our girls we have fair evidence among women in Washington, where so many are stranded without homes, friends, or fortune. Sixty women have been known to apply at a private school as teachers during the summer months, and most of them ill fitted for earning their living in any position. The political changes in Washington conduce strongly to this state of affairs. It is well known that great improvidence exists among the families of the male and female clerks in the departments in Washington as to their manner of living. Many a clerk receiving eighteen hundred or two thousand dollars a year will die, after twenty years or more, without having saved a cent, even for his own funeral expenses, leaving a family with extravagant habits to battle with the world as best they can. This is no uncommon case; to be saving and buy a home is the exception.

I can only give out a few hints on this great subject; but I venture to hope that reflective minds may be impressed with its importance, and may exert their influence to encourage the teaching of the underlying principles of economy and moderation to our children in the public schools.

Laura Osborne Talbott.

THE BASIS OF MORALITY.

Editor Popular Science Monthly:

Sir: I have read Herbert Spencer's The Data of Ethics, and, if I have not misunderstood the work, it teaches that the object to be gained by pursuing morality is happiness, and that a nation's happiness increases as does its morality. If by the term happiness we mean surplus of pleasure over pain, I think that the happiness of savage nations is greater than that of civilized ones. The former are certainly healthier. By our definition this fact alone indicates greater happiness. But savage nations are notoriously immoral. People, whether religious or not, when they argue against immorality, generally give reasons for its avoidance which issue from the heart and sentiment rather than from the mind.

Here are some instances: We say that a man who has been a miser all his lifetime is wretched and unhappy; yet he may have been in perfect health, bodily and mental, which we must assume to indicate that he has been able to exercise all his faculties: and the exercise of faculties, according to Spencer, constitutes pleasure. Persons unable to stick to one occupation for any length of time are often spoken of in terms of pity, yet they also may have led lives of perfect activity. In the former case the means by which the miser accumulated his fortune are held up to us as directly causing pain to the user of them, and we are warned not to follow his steps, for he must have suffered. In reality, however, he could not have suffered so terribly, for if he had he would not have been left in the possession of the power to exercise all his faculties. By similar reasoning we can come to a like conclusion in regard to the vacillating kind of people I have spoken of. People make a mistake in looking at such things through only their own eyes.

An instance of the opposite kind in behalf of the pursuit of morality is as follows: After hearing the biography of two persons, one of whom led a long, healthy, selfish life, and the other, having all the advantages of education, was possessed of a sympathetic and an emotional nature which recognized and met the wants of others, and who during his lifetime was universally loved but constantly suffered, most of us would prefer the life of the latter.

With the idea of happiness in mind we started with, I think the above instances show that the cultivation of morality is not necessarily accompanied by increased happiness. Now, if what I have said is true, it seems to me that the logic of the book in question is destroyed, and that all those who are interested in the furtherance of morality and the scientific discussion of ethics are obliged to face a disagreeable conclusion. It is this: Philosophic thinkers can really give no adequate reason for the pursuit of morality, and they, too, as well as professed believers in other-world motives for doing right, must often argue from the heart and according to their ideals and not as inexorable reason and logic demand; and must be content to live somewhat under a contradiction. I use the word professed not unthinkingly, as I believe that most really honorable people find their motives for rectitude in the present life.

To the possible objection to my argument that I have forgotten to take into account the increase of complexity of the pleasures which takes place as an organism becomes more moral, I may say that so do the pains become more complex.

I might also ask the question, Which pleasures are the greater, the simple ones of childhood, or the complex pleasures of maturity? It seems to me that there is no difference.

K.

Somerville, Mass., *November*, 1890.

EDITOR'S TABLE.

THE EVOLUTIONARY VIEW OF MORALITY.

OUR correspondent "K.," whose letter we publish on another page, is in serious trouble over the difficulty he finds in reconciling the view of morality given by Mr. Spencer, in his Data of Ethics, with the facts of real life. Mr. Spencer, as "K." understands him, teaches that "the object to be gained by pursuing morality is happiness"; while facts teach that morality sometimes calls for the sacrifice of happiness. Mr. Spencer strives to base morality on a foundation of reason, whereas experience seems to prove that it must to a large extent be based on sentiment—that, unless there is a heart impulse toward morality, there will be a lack of power to do the right, except in so far as it may also be the convenient. Therefore, as philosophy does not deal with or control the heart, it fails to furnish any adequate reason for the pursuit of morality.

Our correspondent has done well to express in plain language the thoughts that trouble him, and that such thoughts should trouble him is a sign that his own moral nature is in a state of healthy activity. We hope, however, to be able to show that the evolutionary system of ethics is not in conflict with experience, and that it renders important help to the cause of morality by giving a clear and consistent idea of what morality is. It is a mistake to suppose that it does much more than this. It does not claim to supply any incentives to right action, or any dissuasions from wrong action, other than may be found in a consideration of the consequences which such actions entail. We do not ask the physician or the hygienist to provide people with motives, beyond what the facts they state may furnish, for seeking health or avoiding sickness; yet no one, we think, will question that the diffusion of sound medical and hygienic information has an important effect in promoting the health of the community. The probability is that "K.," like many others who are feeling their way to the scientific standpoint, is still more or less under the influence of moral systems which bring the *sanctions* of conduct into far greater prominence than the essential nature of conduct. Systems that do this, and that place their sanctions mainly in another world, do much to retard the proper definition of morality. While men's minds are strongly occupied with the thought of rewards and punishments beyond all human measurement, the only question that seems to have any pertinence is, How am I to secure this infinite reward? How can I hope to escape that terrible penalty? The overwhelming character of the sanctions compels unquestioning submission to whatever code of morals may be promulgated in connection with them; and future systems of morality come to be judged, not so much by the nature of their ethical teaching, as by the motives they bring to bear in support of it.

This, however, we maintain, is not the right point of view. The business of a moral system is to define morality, not to enforce it; to trace the consequences and relations of actions, not to supplement deficiencies in the general scheme of things. If the decay of arbitrary sanctions leaves certain individuals unprotected against their own lawless tendencies, we can not be altogether surprised, and should not be unduly discouraged. No change, political, social, or intellectual, finds all persons equally prepared to meet it. The wise are those whose lamps are trimmed and fed, and who can light themselves to a place of light: the foolish are those whose lamps are empty and untrimmed, and who, on a sudden call, can only stumble about in darkness. Evolutionary ethics are not discredited because there are those whose imperfect moral development craves inducements and restraints of a more imperative nature than any system which appeals merely to reason and good feeling can supply. "But why," our correspondent may ask, "do you bring in good feeling? My complaint is precisely that, while the evolutionary system professes to dispense with feeling, it does not and can not really do so." We know this is a common idea, but it is not a correct one. Feeling arises when habits have become so consolidated that their origin and justification, if not forgotten, are at least overlooked, so that they seem to be, as it were, self-justified. Feelings and prejudices are of kindred nature: where there is feeling there is, generally speaking, prejudice; where there is prejudice there is always feeling. In feeling we have the stored-up energy of repeated perceptions, and it acts as a fly-wheel to carry us past many a dead point of balanced calculations. The evolutionist shows that moral actions are those which specifically tend to produce happiness—to make life as a whole not only worth living but capable of being lived, if we may be allowed the expression. We all want life, and we want it more abundantly. Evolutionary ethics show how life in general is promoted and enlarged by certain acts, how it is impeded and straitened and undermined by others; nor can there be any reasonable doubt as to the validity of the classification thus established. Mr. Spencer does not say to each individual, "You will in every case find your personal happiness promoted by every moral act you may perform, and the more moral you are the happier you will surely be." He might, however, say: "In performing any moral act from a moral motive you will be sure to reap a certain satisfaction—the satisfaction that comes from having placed yourself in harmony with a law that you feel to be universal in its application; but whether," he might add, "your happiness as a whole will be promoted will depend upon how far in your particular case such satisfaction outweighs any loss or suffering which the performance of the act may entail. That is not a question that can be settled on general grounds; it depends on an equation in which your own moral nature as at present developed is the most important element." In order to determine whether an act is a moral act, what we have to do is to fix its relation to life as a whole, its specific tendency to promote or diminish happiness. To trace its thousand possible incidences in individual cases would be beyond human wisdom, and would be of little value if accomplished. To appeal to right feeling—to come back to a point that ought to be made very clear—is to appeal to a force that we know to have been accumulated through the performance of right acts—acts which, each in their own hour, have yielded up to the moral nature the satisfaction that comes from right conduct, and thus furnished a fund of virtuous impulse for future use. Far, therefore, from there being any incompatibility between the sanction of reason and the sanction of feeling, the two are but one sanction; the only difference being that one is special to the act at the moment under consideration, while the other is the great closed register of past moral judgments.

Of course, it is open to any man to say: "There is no morality in my composition, no feeling or prejudice in favor of what you call right courses of action, no perception of anything as desirable that does not make for my personal gratification; and therefore to me your scientific morality is equally without meaning and without authority." A man who spoke in that way would probably libel himself; but, in so far as we assume that he speaks the truth, we have to admit that he is a more suitable subject for a severely authoritative *régime* than for any system of intellectual and moral liberty. Such a man doubtless needs the most alluring inducements on the one hand, and the direst threatenings on the other, to keep him from frequent transgressions. Not that the transgressions themselves would not in many cases entail punishments which, had they been foreseen, would have deterred him from misconduct, but simply because when a man is so constituted that, without any prepossession in favor of right-doing, he calculates over again on each occasion the probable consequences of a given act, the voice of present passion or desire is very apt to dominate all other pleas. Such a man is a mere moral pauper, starving himself on "beggarly elements," instead of nourishing himself and building himself up on well-developed moral principles. Long before Mr. Spencer, the English philosopher Hobbes dealt very well with this point. "The fool hath said in his heart there is no such thing as justice; and sometimes also with his tongue; seriously alleging that, every man's conservation and contentment being committed to his own care, there could be no reason why every man might not do what he thought conduced thereunto; and therefore also to make or not make, keep or not keep, covenants was not against reason when it conduced to one's own benefit." After thus stating the case of "the fool," Hobbes goes on to point out that such a man takes up a position of hostility to society, and therefore "can in reason expect no other means of safety than what can be had from his own single power," and "can not be received in any society that unite themselves for peace and defense, but by the error of them that receive him." His conclusion is that "justice is a rule of reason by which we are forbidden to do anything destructive to our life, and consequently a law of Nature."

The fool who says in his heart that there is no such thing as justice is generally enough of a knave not to say it aloud; and so far he pays homage to what he recognizes as a settled conviction of mankind. The science of ethics teaches us how conduct becomes ethical in its character, through what successively higher stages it passes, and wherein a true moral equilibrium consists. It can do no more. It is for every man to determine for himself how far he is influenced or means to be influenced by the knowledge that certain courses of action make for the elevation of his own character and the benefit of the world, while others make in an entirely opposite direction. If any man declares that such a manifestation of the truth influences him not at all, it would be well for him to seek the restraints and persuasives of some other system; or, if he means to enter upon a war against society, to take his measures with the greatest caution. It is some satisfaction to think that, among those who take the scientific view of ethics, there is rather more inclination of the heart toward what is right than among those who reject that view chiefly on the ground of its too feeble sanctions. "K." himself seems to admit this, and, if so, we do not see why he should feel discouraged. In conclusion, we may say that, if we have not fully met our correspondent's difficulties, we shall be happy to return to the subject, and deal as specifically as possible with any point he may suggest for discussion. We say this, not because there are not many other questions claiming attention, but because we are strongly convinced that there is not to-day a more important issue than this of the soundness and sufficiency of the evolutionary view of ethics.

CULTURE FOR ITS OWN SAKE.

This is a thing a good deal talked about, but which does not bear very close investigation. All work, all effort must have an object; otherwise it is not determined to any end, guided in any definite channel, or impressed with any distinct character. The culture of the mind, like the culture of a field, must have an object. We cultivate the field that we may get better crops from it; we cultivate the mind that it too may yield better fruits. Nature in its spontaneous workings gives us the starting-point in both cases. She supplies the wild varieties of grain and other vegetable food, and man by his art improves her gifts, rendering them more adapted to his own special needs. In like manner the mind spontaneously working, without any thought of culture or training, lays hold of the facts which Nature presents to the senses and interprets them from its own standpoint. As the interpretation becomes wider through experience, new facts come into view, and knowledge and thought increase with even step. The object of all culture is, therefore, or should be, to give the power of broadly interpreting the data of sense, to place the individual in the most advantageous position possible for understanding the world in which he lives, and exerting a useful action upon some part of it. A culture that is severed from all ideas of utility is something altogether empty and nebulous; we may go further and say that it is something that tends to corruption. What does the decay of societies through luxury—that staple and by no means unreal theme of moralizing historians—mean, if not the corruption that comes of divorcing culture from service? Knowledge grows, art develops, wealth increases; and men forget that these should have a social destination and not merely be made ministers to pride and vanity and lust. For want of a healthy outlet for these forces a process of social decomposition sets in, and another page of history draws to a close.

Every man and woman, therefore, who seeks culture should seek it with reference to some definite aim in life, and not to make it serve as mere intellectual finery. The time has not yet come when we can safely intermit our efforts for the improvement of the social state; and all gifts and accomplishments can be pressed into the service of mankind, if only the motive for so employing them be present. It is when we consider our talents or our knowledge as serving only for our own glorification that they spoil on our hands. What more pitiful can be imagined than the small jealousy which is often found animating literary, artistic, and even scientific circles? It is hard to say whether the mutual admiration or the mutual depreciation of certain devotees of culture is the more ridiculous. All this comes of the "culture for its own sake" theory. Give culture an ulterior end, and it is at once ennobled and justified. The scholar, the man of science, the poet, the painter, the sculptor, the musician, will pursue their several tasks with no less devotion or success for thinking that, however little their work may be comprehended by the world at large, there is that in it in which even the world at large has a practical interest. If a man can not think this—that is to say, can not think it truly—then his work does not make for culture and might profitably be abandoned. Man lives by his faculties; culture is the enlargement or improvement of faculty in one direction or another, and makes thus for fuller life and deeper correspondence between the individual and the world. Governed by a social motive, it will seek to extend its benefits to all—as an ultimate aim—and will thus be kept fresh, vigorous, and pure. Governed by a selfish motive, it will degenerate into mere self-pleasing, affectation, and insincerity, and will never be far removed from moral corruption. The distinction is easily seized, and may profitably be taken to heart.

LITERARY NOTICES.

Civil Government in the United States considered, with some Reference to its Origins. By John Fiske. Boston and New York: Houghton, Mifflin & Co. Pp. xxx + 360.

If not the most important book that Mr. Fiske has written, this is, without doubt, one of the most useful. The plan of it is good, the spirit of it is good, the execution of it is good. Lucid arrangement seems to come naturally to Mr. Fiske, and to lucidity of arrangement he is always able to add extreme felicity of expression. With this book accessible to him, no American, young or old, can have any excuse for remaining ignorant of the leading facts in connection either with the political development or the existing political structure of his native country. Here we have the story told in the simplest language, and in a style which is not too vivacious to be serious nor too serious to be vivacious. Moreover, by a happy art in selection, Mr. Fiske has told us just what it is most important to understand and remember. His task is one of narrative and exposition; and he is not, therefore, called upon to any great extent for the expression of his individual opinions. Here and there, however, he has found occasion for a judicious comment or a penetrating criticism, with the result of making us feel regret that his limits did not permit more extended remarks of this character.

In the first chapter he deals with government as the taxing power, and broadly states that the taking of taxes for a wrong purpose, as by a political party in order to strengthen its hold on power, is robbery. In his second he sketches the rise of the township, and shows the connection existing between this primary political unit and the church congregation. The important functions exercised by the township authorities are fully described, and justice is done to the politically educative effect of township institutions. Very instructive parallels are drawn between the institutions of the parent state and those established on American soil. Except the development of our written Constitution, every bit of civil government described in his pages came to America, says Mr. Fiske, "directly from England, and not a bit of it from any other country unless by being first filtered through England." Much detailed information is given as to the local circumstances which helped to mold the development of counties and States in different parts of the country. Chapter V, on "The City," is most important. Here, again, our author takes us to the old land, and shows us the development of the Roman camp or military settlement into a burg, and the gradual growth in the burg of principles and traditions of liberty, though in many of them oligarchical tendencies became manifest in course of time, giving rise to the "rotten boroughs" which, on the political side, were dealt with by the Reform Act of 1832, and, on the civic side, by the Municipal Reform Act of 1835. It was the constitution of the English city or borough that determined the constitution of the first city governments established in this country; and here, too, a distinct tendency toward oligarchy, with its attendant evils, began to make itself felt. The city government, instead of being freely elected by the people, was, after the pattern of the English borough, a self-perpetuating corporation with a very limited responsibility to the citizens in general. In course of time this system was abolished; freedom of election for all city officers was established; and then, unfortunately, other evils set in, evils which perhaps reached their height in this city some twenty years ago. The tendency of late years in our cities, as Mr. Fiske points out, has been to concentrate larger powers in the hands of the mayor, and to fasten on him a proportionately heavy responsibility. "A hundred years ago," the author remarks, "our legislators and Constitution-makers were much afraid of what was called the 'one-man power.'" To-day we are getting to be more afraid of the myriad-headed tyrant, with its manager, "the ring." Fifty years ago to have had so few elective officers as, for example, there are in the neighboring city of Brooklyn, and so many nominated by one man, would, we are told, "have greatly shocked all good Americans." To-day we feel that we are safer in the hands of one honest man of good judgment, who knows that the eyes of all the citizens are fixed on him, than in those of any body of elected officers, each with only a partial and more or less doubtful responsibility. Mr. Fiske recalls one fact which should not be lost sight of, and that is the danger the finances of a city are sometimes exposed to, not from the votes of the poorer members of the community, but from the machinations of the richer, who have it in their power to bring the most corrupting influences to bear on city councils, with a view to obtaining grants for improvements quite unnecessary on public grounds, but eminently useful for increasing the value of private properties. Universal suffrage has not been the sole fount of our municipal troubles.

"The purification of our city governments," says Mr. Fiske, "will never be completed until they are entirely divorced from national party politics." This is a view which a leading newspaper in this city loses no opportunity to ridicule, but which we think founded in good sense. The matter does not admit of discussion here, further than to say that this is a subject on which the experience of England can be appealed to. As our author observes, "The degradation of so many English boroughs and cities during the Tudor and Stuart periods was chiefly due to the encroachment of national politics upon municipal politics."

The rise of our Federal Constitution is well and graphically sketched; and in a few words the distinction between the two great political parties is well established. It is pointed out that, whereas the tariff question was formerly debated as a constitutional one, the predecessors of the present Democrats holding that Congress had no power under the Constitution to impose taxes for the purpose of advancing or protecting certain industries, it is now debated on economical grounds alone. The former view of the matter, however, we venture to hold, has not lost its pertinence, and we are not without hope that the citizens of this free republic will yet see that the tariff question is one in which their liberties are at stake. Mr. Fiske, as might be expected, has placed himself clearly on record as a friend and advocate of civil-service reform. Of the historic declaration that "to the victors belong the spoils," he observes that "the man who said this (W. L. Marcy) did not realize that he was making one of the most shameful remarks recorded in history."

There are appended to the volume some valuable and interesting historical documents, such as Magna Charta, the Constitution of the United States, with its amendments, etc. At the end of each chapter is a set of well-chosen questions, adding not a little to the value of the book for educational purposes. Mr. Fiske has produced a work which can not fail to be widely read, and which will do much to develop a spirit of intelligent and high-minded American citizenship.

Wild Beasts and their Ways. By Sir Samuel W. Baker, F. R. S., etc. London and New York: Macmillan & Co. Pp. 455. Price, $3.50.

Sir Samuel Baker's last book of hunting adventures is a model of its class. Its accounts of hunts are spirited and fascinating, being neither too much nor too little detailed. Moreover, it is not made up solely of the circumstances of killing certain animals in specified places. It gives, in addition, the results of a vast deal of highly intelligent observation in regard to the nature and habits of the creatures that have fallen to the rifle of this humane and cultivated sportsman, as well as of the domesticated animals—horse, dog, elephant, and camel—which he employed in different expeditions. Many incidents of an amusing nature are included, the telling of which affords play for the delightful wit of the author. The greater part of the volume is devoted to large game—the tiger, leopard, lion, bear, hippopotamus, crocodile, buffalo, bison, and rhinoceros. Other animals included are the boar, hyena, giraffe, and various species of the deer family. The opening chapter deals with the development of the rifle during the past half-century, embodying Sir Samuel's reasons for preferring the sorts of arms and ammunition that he has used for different game. Following this are three chapters devoted to the elephant and his ways when tamed, including his behavior when employed for hunting tigers, etc. In all parts of the book appear traits of the animals described which will be new to many even who are well read in zoölogy. It appears that the elephant, who is generally thought of as a slow and lumbering, bulky body, can kick with extreme quickness and naturally with great force. "This is a peculiar action," says our author. "As the elephant is devoid of hocks, and it uses the knees of the hind legs in a similar manner to those of a human being, therefore a backward kick would seem unnatural; but the elephant can kick both backward and forward with equal dexterity, and this constitutes a special means of defense against an enemy, which seldom escapes when exposed to such a game between the fore and hind feet of the infuriated animal." In Sir Samuel's opinion, the intelligence of the elephant has been overrated. It has a wonderful power of learning, and hence can be taught to perform a great many acts on command, but it will never volunteer any service for its master. "There is no elephant that I ever saw," he says, "who would spontaneously interfere to save his master from drowning or attack. An enemy might assassinate you at the feet of your favorite elephant, but he would never attempt to interfere in your defense; he would probably run away, or remain impassive, unless guided and instructed by his *mahout*." Sir Samuel has evidently been fond of tiger-hunting, for he recounts many exciting adventures with this dangerous game, the incidents of which make up a very full picture of tiger character. He has also hunted the lion, though evidently with less interest, as he says that he does "not consider the lion to be so formidable or ferocious as the tiger." Bears he has hunted in Ceylon and in Wyoming. He apologizes for admitting the crocodile, which he numbers among "vermin," to a place with the other animals that he describes. But he makes a very interesting chapter about them, in which he states that he has slaughtered a vast number of these reptiles in revenge for their killing his men. "On one occasion," he says, "I killed a crocodile which, although not longer than twelve feet three inches, was very thick in the body; this was proved to be a malefactor by the testimony of two bracelets and a necklace, belonging to a missing girl, which we found within its stomach." Sir Samuel's chapters on deer-hunting take us through Scotland, India, Ceylon, and the Rocky Mountains, and are full of interest, though without the dangerous situations included in the earlier chapters. Besides the ways of wild beasts, something may be learned from this book of the ways of the human inhabitants of the countries in which the author has hunted. Judging, however, from the speeches he puts into the mouths of American hunters, he does not attempt to report conversations *verbatim*. In conclusion, some observations are given in regard to animals that have not been objects of his pursuit—monkeys, bats, wild asses, and camels. A number of appropriate full-page illustrations embellish the volume.

Prehistoric America. By the Marquis de Nadaillac. Translated by N. D'Anvers. Edited by W. H. Dall. New York: G. P. Putnam's Sons. Pp. 566. Price, $2.25.

This valuable work was published in French in 1882, and the translation, modified and revised by Mr. W. H. Dall so as to "bring it into harmony with the results of recent investigation and the conclusions of the best authorities on the archæology of the United States," was first issued two years later. A popular edition of the translation is now brought out at less than half the price of the former issue. For the benefit of those who have not seen the book, we will say that it is a comprehensive work, describing the human remains and the relics of human workmanship that have been found in both North and South America. Besides the purely descriptive matter, discussions are introduced concerning the origin of man in America, the length of time that he has lived there, etc. Thus, the first chapter is a summary of the evidence tending to show that man lived in America with the mastodon and other gigantic extinct animals. The second chapter sketches the discoveries made in American kitchen-middens and caves. The next two chapters are devoted to the mound-builders and their works, and review the questions that the discovery of these remains has raised. In like manner the relics of the cliff-dwellers and of the denizens of the ancient *pueblos* are described. Passing from the United States southward, the author gives an account of the ruins of Central America, and finally records the evidences of ancient life that have been found in Peru. He then proceeds to draw conclusions from the material thus furnished in regard to the physique of the early men of America. The volume contains two hundred and nineteen illustrations and has an index.

THE VETO POWER. By EDWARD C. MASON. Harvard Historical Monographs, No. 1. Edited by Albert B. Hart. Boston: Ginn & Co. Pp. 232. Price, $1.

THE first number of what promises to be a valuable series of publications has been issued by Harvard University. It gives the history of presidential vetoes in the United States from 1789 to 1889. This record is introduced by an account of the origin in English and colonial precedent of that particular form of the veto power which is found in the United States. Different classes of vetoes are discussed in successive chapters, namely, those affecting the form of government, those affecting the distribution of the powers of government, and those affecting the exercise of these powers. A chapter is added on the constitutional points which have arisen concerning the operation of the veto power, and another on the development of this function during the completed century of our national history. Appendix A is a chronological list of all bills vetoed from April 6, 1789, to March 4, 1889, with dates and references to the journals of Congress containing the legislative histories of the bills. Five other appendixes contain similar lists and tables. The editor states that both the author and he have endeavored to make this work free from political bias, and that "the vetoes are condemned or approved upon what seem to us sound principles of constitutional law and political expediency, irrespective of the attitude of present parties."

INTERNATIONAL JOURNAL OF ETHICS. Vol. I, No. 1; October, 1890. Issued quarterly. Philadelphia, 1602 Chestnut Street. Price, $2 yearly; single number, 50 cents.

WE are confident that the world will profit from the founding of this magazine. It is designed to do work which must greatly aid the elevation of human character and the increase of human happiness. It is the successor of The Ethical Record, and it is more than this. The announcement states that the Journal will be devoted to the advancement of ethical knowledge and practice, and that it will not be the organ of any society or sect or of any particular set of opinions. The word International in its name is justified by the composition of its editorial committee, which consists of Felix Adler, Ph. D., New York; Stanton Coit, Ph. D., London; Prof. G. von Gizycki, Berlin; Prof. Fr. Jodl, Prague; J. S. Mackenzie, M. A., Manchester; J. H. Muirhead, M. A., London; and Prof. Josiah Royce, of Harvard University. The list of contributors already engaged has a still wider range. Seven body articles and a department of book reviews make up the contents of the first number. The opening article is on The Morality of Strife, by Prof. Henry Sidgwick, of Cambridge University, referring especially to wars. It has been said that the spread of altruism would bring wars between states to an end. Prof. Sidgwick maintains that little improvement would be secured until the predominance of good-will was complete; for, so long as any were wronged, those persons dominated by altruism would still be eager to fight, albeit in behalf of others and not for themselves. To the proposition that strife can generally be prevented by competent arbitration, Prof. Sidgwick objects that this "external" mode of solution can not be applied to all cases, and he thinks it inevitable that, "at least for a long time to come, every nation in the most important matters must to an important extent be judge in its own cause." Therefore "we must endeavor to be just judges." Prof. Felix Adler contributes an article on The Freedom of Ethical Fellowship, in which he states that it is the aim of the Ethical Societies "to unite men of diverse opinions and beliefs in the common endeavor to explore the field of duty," and "to embody the new insight in manners and institutions." Prof. Adler says further: "Ethics is both a science and an art. As a science its business is to explain the facts of the moral life. In order, therefore, to improve it as a science it is necessary, before all, to fix attention on the facts, to collect them, to bring them into view, especially the more recondite among them. It is necessary to effect in the treatment of the subject a revolution analogous to that which has taken place in the natural sciences, namely, instead of beginning with theories and descending to facts, to begin with the facts and to test theories by their fitness to account for the facts." The Popular Science Monthly has always held that there can be no substantial and lasting morality without a basis in inductive science. We maintained this at a time when the doctrine had few avowed friends and many active enemies. We are exceedingly gratified that now a dignified and ably edited magazine has been established in which this idea can have free and full expression. Among the other articles in this number of the Journal is The Law of Relativity in Ethics, in which the author, Prof. Harald Höffding, of Copenhagen University, maintains that "in an ideal state only that would be demanded of each individual which lay within his range and power." Prof. J. B. Clark, of Smith College, has a paper on The Ethics of Land Tenure, in defense of private ownership in land. Bernard Bosanquet writes on The Communication of Moral Ideas as a Function of an Ethical Society. Dr. Abbot's "Way out of Agnosticism" is criticised by Prof. Royce very fully and freely. As to this author's mode of thinking, Prof. Royce says, "Dr. Abbot's way is not careful, is not novel, and, when thus set forth to the people as new and bold and American, it is likely to do precisely as much harm to careful inquiry as it gets influence over immature or imperfectly trained minds." A brief paper on A Service of Ethics to Philosophy, by William M. Salter, of Chicago, suggests that "ethics not only enlarges our philosophy by opening to our view higher heights or deeper depths than Science is aware of, but it gives us something ultimate in philosophy, ideas that may be fairly classed as ultimate truths." The Journal's book reviews are all signed.

Emblematic Mounds and Animal Effigies By Stephen D. Peet. Chicago: American Antiquarian Office. Pp 350. Price, $3.50.

This book is the second volume of a series to which the author has given the name of Nadaillac's work—Prehistoric America. It is devoted to describing those mounds of various shapes in our Western States which it is thought were intended to represent the forms of certain animals. The author has aimed to describe all the effigy mounds in the country; hence the volume, which is based on his own explorations in Wisconsin, Iowa, and Ohio, includes also the results gathered by other explorers in the same States and in Dakota, Georgia, and Florida. The descriptions are illustrated with two hundred and thirty-seven cuts, besides numerous plates, comprising plans of mounds, maps of the localities in which they have been found, and drawings of articles of aboriginal workmanship. The figures of mounds are generally silhouettes. The author gives the following as the points that he has sought to bring out by his explorations and descriptions: "1. The effigies were undoubtedly imitations of the wild animals which were once common in the region, but they are at the same time totemic in their character and may be supposed to represent many things in the clan life of the people. 2. The effigies are interesting as works of art, but, at the same time, they were evidently used for practical purposes, such as screens for hunters, guards for villages, foundations for houses, heaps on which sentinels were stationed. 3. There are some remarkable features embodied in the effigies which render them especially interesting, since they reveal certain strange superstitions and customs which are rarely found, but which are suggestive of the religious system prevalent in prehistoric times. 4. The question, Who built the effigies? is treated briefly, but is left undecided." The successive chapters deal with special divisions of the subject, such as the animals represented by the effigies, religious character of the emblematic mounds, the location of the effigies as related to the topography, etc. The author is editor of The American Antiquarian.

Sugar Analysis. By Ferdinand G. Wiechmann, Ph. D. New York: John Wiley & Sons. Pp. 187. Price, $2.50.

This work is designed to be an authority for use in refineries, sugar-houses, experimental stations, schools of technology, etc. Within the past few years numerous new methods and modifications in old methods of sugar analysis have been brought forward, and many researches of importance to the chemistry of sugar have been accomplished. This material is scattered through so many publications, some of them being foreign journals not readily accessible, that it can be of use to the majority of American students and practicing chemists only when the best of it is selected and embodied in a manual like the present one. The schemes of analysis here presented embrace those which, "after careful investigation, and, in many cases, after prolonged trial in practice, have seemed to the writer best adapted to the requirements of a technical laboratory." Dr. Wiechmann has avoided many repetitions by giving the methods of determining each constituent of saccharine substances once for all, and adding such suggestions as special cases call for, instead of giving a complete scheme of analysis for each product of the sugar manufacture. The opening chapters contain directions for the use of polariscopes, hydrometers, and other instruments and apparatus, for the verification of hydrometers, balances, and graduated vessels, and for the sampling of sugars and molasses. The methods for optical and chemical analysis follow, and in conclusion there are given notes on reporting sugar analyses, methods of calculating *rendement*, lists of synonyms in English, French, and German, and references to the literature of sugar analysis. Nineteen tables required in the various operations detailed are appended to the volume. These have been selected by Dr. Wiechmann with great care, and, to secure uniformity of basis, several have been calculated expressly for this volume.

Proceedings of the Boston Society of Natural History. Vol. 24, Parts III and IV. Boston. Pp. 257–597.

These parts conclude the volume, covering the meetings of the society from May, 1889, to April, 1890, inclusive. Among the more extended papers in this portion of the volume is Mr. August F. Foerste's Notes on Clinton Group Fossils, illustrated with nine plates, and containing descriptions of a large number of species. Prof. Alpheus S. Packard contributes a paper on The Life History of *Drepana arcuata*, and another, occupying sixty-seven pages, entitled Hints on the Evolution of the Bristles, Spines, and Tubercles of Certain Caterpillars, apparently resulting from a Change from Low Feeding to Arboreal Habits, illustrated by the Life-Histories of some Notodontians. The latter is accompanied by two plates, and by figures in the text. Messrs. W. M. Davis and J. W. Wood, Jr., publish an account of The Geographic Development of Northern New Jersey, illustrated with fourteen diagrams and small maps. The scope of the investigation embraces a description of the probable course of development of the present geographical features of the highlands in New Jersey, a similar account of the formation of the central plain of the State and the highland valleys, and a discussion of the deformation of the central plain indicated by the present course of the Millstone River. Other papers are by Prof. G. F. Wright, on The Climatic Condition of the Glacial Period; by Mr. Frederick Tuckerman, on The Gustatory Organs of the Mammalia; and by Mr. Samuel H. Scudder, on The Physiognomy of the American Tertiary Hemiptera.

Among the Moths and Butterflies. By Julia P. Ballard. New York: G. P. Putnam's Sons. Pp. 237. Price, $1.50.

This book is a revised and enlarged edition of Insect Lives; or, Born in Prison, and is devoted to the natural history of the insects named in the title. It is written for children, but the author does not take the trouble to express herself uniformly in words with which children are familiar. The two following passages illustrate the different styles of language that are mingled throughout the volume. The first chapter opens thus: "I am only a day old! I wonder if every butterfly comes into the world to find such queer things about him? I was born in prison. I can see right through my walls; but I can't find any door." Simple enough for any child to understand; and the following sentence from the top of page 35 contrasts strangely with it: "No philosopher ever showed more patience and dignity under repeated trials at the hands of a photographer than he displayed in the hands of his persecutors, with no knowledge of the cause to stimulate his vanity and inspire his courage." This is not an isolated case. Nearly every page bristles with polysyllables, very few of which can be excused by the plea that they are needed to secure scientifically accurate description. We fear that the children who may be condemned to see nature under the guidance of Mrs. Ballard will get a much obstructed view of it. The volume is handsomely printed and liberally illustrated.

We have received in pamphlet form Prof. *Lester F. Ward's* article on *Genius and Woman's Intuition*, published in the Forum. It is a reply to an article on Woman's Intuition, by Mr. Grant Allen, who, Prof. Ward says, entirely mistakes the nature of this faculty. It is defined by Prof. Ward as a power of instantaneous accurate judgment in matters that affect the safety of the woman or her children. Out of its own field this instantaneous judgment fails to be accurate, which is the reason why men are unwilling to trust the conclusions of women on the broader questions of society and the state. Prof. Ward maintains, also, that Mr. Allen errs in identifying genius with the intuition of woman, and speaks of the former as essentially a creative faculty, which man as a rule possesses to a greater degree than woman.

The *Journal of Morphology* (Ginn) opens its fourth volume with a number containing five papers. These are The Origin of the Cerebral Cortex and the Homologies of the Optic Lobe Layers in the Lower Vertebrates, by Isaac Nakagawa; The Skeletal Anatomy of Amphiuma during its Earlier Stages, by O. P. Hay; The Segmentation of the Primitive Vertebrate Brain, by Charles F. W. McClure; and two by Mr. W. H. Howell, one being on The Life History of the Formed Elements of the Blood, especially the Red Blood Corpuscles, the other being occupied with Observations upon the Occurrence, Structure, and Function of the Giant Cells of the Marrow. Three folded plates accompany the issue.

Bulletin No. 63 of The Michigan Agricultural Experiment Station is a pamphlet on *Greenhouse Building and Heating*, by *L. R. Taft.* "The greatest defects in the ordinary forcing house," Mr. Taft says, "are, that there is generally too much wood in the roof in the shape of rafters and sash-bars, and that sufficient care is not taken to so erect them that they will not rot down, or the walls, if of brick or of masonry, be broken apart or thrown down by frost." He discusses the material for walls, the arrangement of sash bars and supports, methods of glazing, ventilating apparatus, steam and hot-water heating, etc.

The Second Annual Report of the Storrs School Agricultural Experiment Station, at Storrs, Conn., contains the following papers: The Acquisition of Atmospheric Nitrogen by Plants, by W. O. Atwater and C. D. Woods; Bacteria in Milk, Cream, and Butter, by H. W. Conn; Stubble and Roots of Plants as Manure, by Charles D. Woods; Meteorological Observations, by C. S. Phelps; Co-operative Field Experiments with Fertilizers, by C. S. Phelps; and Effects of Different Fertilizers upon the Composition of Corn, by Charles D. Woods.

The papers contributed to the *Second Annual Report of the Experiment Station*, at the Kansas Agricultural College, by the *Botanical Department* of the station, comprise a Report on the Loose Smuts of Cereals; an account of Experiments in Crossing Varieties of Corn; Observations on Crossed Corn the Second Year; and Brief Notes of a Preliminary Study of the Receptivity of Corn Silk. Nine plates illustrate the smuts and their natural enemies, and two are devoted to the crossed corn.

A Chart Relative to the Composition, Digestibility, and Nutritive Value of Food has been prepared by Prof. *Henry A. Mott* (Wiley, $1.25). It contains a large number of tables of the nature indicated by the title, the authority for each and the name of the publication from which the table is taken being given. A few general comments on the digestibility of foods are given in a foot-note.

The first number of a magazine whose purpose is indicated by its name—*Physical Culture*—has been issued in New York. Its editor is *Archibald Cuthbertson*, who says that his magazine will endeavor to avoid publishing articles simply because subscribed by a prominent name. "Physical Culture will stand or fall, not by or for lack of certain names appended to its articles, but by the quality of these attributed to them by intelligent people." Accordingly, except the opening article, "by the editor," none of the papers in this issue are signed at all, and certain marks indicate that they are mostly the product of one pen. The number contains a biographical sketch of James Douglas Andrews, illustrated with a full-page portrait of Prof. Andrews, and a view of the interior of the Brooklyn Young Men's Christian Association Gymnasium. Other articles take up The Checkley System, Jenness Miller and her Work, Color and Calisthenics, Prohibition, etc. The price is $2 a year.

Prof. *Robert T. Hill* contributes to the First Annual Report of the Geological Survey of Texas *A Brief Description of the Cretaceous Rocks of Texas, and their Economic Value*. The areas covered by these rocks comprise the tracts known as the Black Prairie, the Grand Prairie, the two Cross Timbers, and certain smaller regions. These form a broad belt of fertile country across the heart of the State, in which lie the principal inland cities of Texas. Prof. Hill's paper describes and locates the several deposits of chalky sands, chalky clays, and chalky limestones which make up the surface formations of this territory. The author gives also a table in which the arrangement of the rock sheets is summarized, and describes the main disturbances of the strata, illustrating them with a diagram. The several economic features of the Cretaceous system are touched upon by themselves, and the investigations in regard to them which the geologists of the survey hope to make are alluded to.

We have received an address by Colonel *George E. Waring, Jr.*, on *The Sewerage of Columbus, Ohio*, which, although largely local in application, contains also the latest views of this well-known sanitary engineer on the general subject of sewerage. An interesting discussion that followed the delivery of the address is printed with it, and brings out a number of points more fully and clearly than is usually done in continuous treatises.

The Wagner Free Institute of Science of Philadelphia devotes the third volume of its Transactions to *Contributions to the Tertiary Fauna of Florida*, by *William H. Dall*. Part I of Mr. Dall's contributions—on Pulmonate, Opisthobranchiate, and Orthodont Gastropods—occupies the whole of the volume. The text is accompanied by twelve fine plates, each containing from ten to twenty figures.

The New England Meteorological Society has issued a volume of *Investigations for the Year 1889*, prepared under the supervision of its new director, Prof. W. M. Davis. In addition to the tabulated reports of observers, and the review of the year's weather, which the society publishes yearly, this volume contains several papers on special topics. The most extended of these is an Investigation of the Sea-breeze, conducted by W. M. Davis, L. G. Schultz, and R. De C. Ward, with the aid of observers at over one hundred stations. There is also a short paper on Characteristics of New England Climate, by Prof. Winslow Upton.

Among the reprints which have come to us is an essay on *Tornadoes*, by *A. McAdie*, which won the second prize in a recent competition, and was published in The American Meteorological Journal. It is a technical discussion of the nature of tornadoes and the practicability of predicting them. The author believes that a careful study of the secondary whirlings in the atmosphere would reveal the causes of the seeming irregularities of the primary whirlings, and make possible not only the prediction of tornadoes, but also greater success in foretelling general weather conditions.

William L. Green issues from Honolulu a pamphlet under the title *Notice of Prof. James D. Dana's "Characteristics of Volcanoes,"* in which he criticises certain statements in Prof. Dana's work that differ from his own views and observations, as published in his Vestiges of the Molten Globe.

The president's address at the thirteenth annual meeting of the American Bar Association, delivered by *Henry Hitchcock*, LL. D., has been printed from the Proceedings of the Association, with the title *A Year's Legislation*. As prescribed it reviews "the most noteworthy changes in the statute law on points of general interest made in the several States and by Congress during the preceding year." The national legislation includes the Administrative Customs bill, the Dependent Pensions act, the Silver bill, and acts in relation to the World's Fair, the admission of six new States into the Union, desertions from the army, an inland quarantine, trusts, the original-package decision, and bridging the Hudson at New York. Mr. Hitchcock expresses regret that no bill had yet been passed for the relief of the Supreme and other courts of the United States. Statutes had been passed by the Legislatures of twenty-one States and Territories during the year which he covers, and he groups those that he mentions under the heads of education and charity, protection of women and children, public safety and morals, labor and trade, legal procedure, development of natural resources, and the machinery of government. Mr. Hitchcock also glances at the Constitutions of the new Northwestern States, and calls attention to both these and the statutes above mentioned as reflecting the life and convictions of the respective communities by which they have been made.

The Ethical Societies welcome to membership all who desire to learn and practice right conduct, without requiring them to accept any particular theory. In fact, the societies as organizations do not teach a definite philosophical system, and take pains not to commit themselves to the views of their own individual lecturers. In the opinion of Dr. *Paul Carus*, they are too colorless in this respect; he thinks they should make an active search for a basis of ethics, and he has published, in a volume entitled *The Ethical Problem* (The Open Court, fifty cents), three lectures embodying his views. He maintains that a system of ethics suited to the present stage of the world must have a basis in facts and in a logical structure. "The facts to be considered in ethics," he says, "are the many and various relations in which man stands to his surroundings. These relations produce the many different motives that prompt men's actions." The function of ethics is to tell us which motives we shall resist and which we shall allow to produce action. Coming to the theories of ethics, Dr. Carus reviews supernaturalism, intuitionalism, utilitarianism, and hedonism, none of which he deems sufficient ground for a system of morality. His own theory is, that man should live not merely to secure happiness for himself, but so as to pass on to posterity a still richer "treasure of human soul-life" than he has himself inherited. But Dr. Carus leaves us still without a criterion for judging what makes human soul-life richer and higher.

Dr. *H. Carrington Bolton* has collected a considerable quantity of very curious information in a special field of coin-lore which he has published in the American Journal of Numismatics, under the title *Contributions of Alchemy to Numismatics*. The paper consists of a preliminary sketch of the aims and practices of the alchemists, followed by detailed descriptions of a large number of coins and medals struck in evidence of alleged transmutations of base metals into gold or silver. The circumstances attending the issue of most of these pieces are also given. Three of them are figured in the paper.

A Digest of English and American Literature, prepared by Mr. *Alfred H. West*, author of Development of English Literature and Language, and published by S. C. Griggs & Co., Chicago, presents a condensed parallel view of history and literature in England and the United States, from the time of the Roman invasion down to the present. It is intended to assist the student to that acquaintance with the characters and leading events among which he wrote which is necessary to the proper comprehension of any of the great writers. That its preparation was suggested by the author's experiences as a teacher is sufficient indication that it is intended practically to meet a real want. The pages facing one another are divided into four columns, in which are presented on one side the events and the characteristics of the period during which the writers flourished, and on the other side the writers by which those periods are distinguished, with brief accounts of their principal writings. The whole forms a connected outline of the successive periods and their literary features.

Mr. *W. H. Babcock* has made an effort, in *The Two Lost Centuries of Britain* (J. B. Lippincott Company), to restore in some shape the history of that country during the transition period of the Saxon conquest. The study is an outgrowth, as he expresses it, of an endeavor to see clearly in his own mind, and for his own purposes, a part of the life of the sixth-century Britain. In executing his purpose, incidents and periods were found linked to one another in such a way that each illustrated and was illustrated by another, and called up still others, the light of which was needed; so that the study grew into a kind of history. The author acknowledges that there may be questions as to whether what he writes is history, because he admits and preserves what is probable, but is not provable in a strict sense.

But if history be a setting forth of the past as the past really was, he reasons, the aid of inference and analogy can not be excluded. An interesting picture is presented of times of which not much is accurately known, for the composing of which the authorities of the chronicles and poems have been collated.

The chronology of historical events, originally compiled by the late *George P. Putnam*, and forming a part of his cyclopædia on The World's Progress, has been revised and brought down to the present time by *Lynds E. Jones*, and is issued in separate form by G. P. Putnam's Sons as *Tabular Views of Universal History*. The tables are arranged in parallel columns, the headings of which vary according to the charcteristics of the succeeding ages, but which usually include a column for each of the leading nations of the time, one for the world elsewhere, often one devoted to ecclesiastical affairs, and always one headed Progress of Society. For ancient Egyptian events, the chronology of Brugsch and Duncker, which puts the erection of the Great Pyramid at about 3700 B. C., is adopted as a compromise between extremes. The earliest Chaldean date is 2234 B. C., for the earliest astronomical observations; and the first Israelite date is about 1055 B. C., for the accession of Saul.

An excellent *Brief History of the Empire State* has been prepared for schools and families by *Welland Hendrick*, and is published by C. W. Bardeen, of Syracuse. The author assumes as one of the reasons why the history of New York deserves to be studied, that the importance of the colony in the making of America has been underrated. That it learned liberty under the Dutch and held to it through a century of English governors; that, handicapped by many disadvantages, it was among the first of the colonies in the war for freedom, and alone of the thirteen met every demand of Congress; and that with its canal it opened the Northwest—entitle it, he thinks, to prominent consideration at least in its own schools. There are also reasons, of a general character, for which he regards the study of State history as profitable.

An Easy Method for Beginners in Latin has been prepared by Prof. *Albert Harkness*, and is published by the American Book Company, with the intention of introducing the learner to such a practical and working knowledge of the Latin language as will enable him to read Cæsar or Nepos with some degree of pleasure. It approaches the subject on the practical side, introducing the student in the first lesson, without a word of grammar, to the complete Latin sentences, with verb, subject, and object.

The *Handbook of Latin Writing* of *Henry Preble* and *Charles P. Parker* grew, in the first place, out of the necessities of class work at Harvard College. The development of Latin writing there and the fuller experience of the authors have suggested modifications, and a new revised edition has been prepared and is published by Ginn & Co. The essential principle of the first edition is retained, but some of the exercises having proved less useful than they were expected to be, others have been substituted for them. The authors, attributing ill-success in Latin writing largely to the habit of translating the words rather than the thought, have been at pains to insist on fastening attention upon the thought, and have tried to show the learner how to express in Latin form the ideas which he has grasped from the English words.

The American Book Company publishes an edition of the *Satires of Juvenal*, edited, after several years of careful study, and a comparison of the views of the best critical editors, and annotated, by *Thomas B. Lindsay*, of Boston University. Thirteen of the sixteen satires are given, and from these such lines are omitted as seemed likely to offend a rational delicacy—a very proper measure for a Juvenal that is to be read in mixed classes. The notes are copious, and the whole work is richly illustrated. The author makes a comparison between Horace and Juvenal as satirists, showing that Horace wrote in a brilliant, hopeful age, and is therefore lively and amusing; while Juvenal, writing in an age of decline, when vices were rife, is contemptuous and bitter.

The short exposition of the Roman method made by *Harry Thurston Peck* in his handbook on *Latin Pronunciation* is principally intended for those persons interested in the study of Latin who have accepted the Roman method without acquainting themselves with the arguments on which it is maintained. It has now received the approval of all Latinists of authority in Europe and America, as giving substantially the pronunciation employed by educated Romans of the Augustan age, and has been formally adopted at our leading universities. After presenting the authorities upon which it has been established, Prof. Peck concludes that "it is not too much to claim that the system of pronunciation upon which scholars are now agreed differs less from that of the Romans of the Augustan age than does our modern pronunciation of English differ from that of Shakespeare and his contemporaries." Published by Henry Holt & Co. (sixty cents).

Much pains is taken in the *Natural Speller and Word Book* (American Book Company) to teach, with the spelling of the words, the proper use of them. The dictation exercises are intended to serve to teach composition and punctuation in addition to spelling. Homonyms are made to serve for memory exercises as well as for spelling, while by introducing the best thoughts of the best authors they become really elementary lessons in literature. Synonyms are introduced to teach discrimination in the use of words, and lessons in etymology to teach the meaning of the common stem in words of like derivation. Important points to be noted in pronunciation are indicated by typographical devices.

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POPULAR MISCELLANY.

Intelligence in Plants.—Mr. T. D. Ingersoll, of Erie, Pa., describes, in Garden and Forest, a Madeira vine which seemed to exhibit intelligence in its growth. When it had become eighteen inches high it began, from top-heaviness, to fall away from the pot, which stood upon a table, toward the floor. "This was done gradually, and apparently with conscious care. It seemed to feel at times that it was letting itself down too fast, when it would stop with a jerk, like a nodding child half asleep." When near the floor it began describing ellipses about three inches in diameter with its upturned extremity. When twenty-seven inches long it would describe a crescent-shaped loop seventeen inches long by six inches broad in about two hours. As it grew longer, its revolutions were accomplished with less regularity, "and at times it drooped as if weary or discouraged in trying to find something upon which it might entwine itself." On one day the track of the tip of the vine was traced and measured, and found to be six feet nine inches in length. Finally, a support was provided for the plant, and it shortly afterward "began growing again as if it had recovered from what had been for six days a condition near the point of death." Another vine, during several days of cloudy weather, uncoiled itself from the stick and reached away toward the light at an angle with the horizon of some forty-five degrees. It was brought back to its support several times and coiled about the stick, but invariably left it during the continuance of the cloudy weather. Then bright weather came on, and it showed no disposition to escape from the stick or stop its twining growth. Attempts to make plants twine in a direction contrary to their natural one were firmly resisted. "All the experiments seemed to show how much like an animal was the plant in its sensitiveness, not only to changes of light and temperature, but to harsh treatment. Whenever restrained or forced, no matter how tenderly, out of its natural method of growth, all progress was retarded and the health of the vine disturbed to a marked degree. Plants seem to be creatures of feeling, and the similarity of movement and of apparent purpose between them and the lower animals are used to strengthen their theory by those who hold to the doctrine of the identity of life in the two kingdoms."

Modern Views of Consumption.—Two things are now believed to be necessary for the production of consumption: the tubercle bacillus and a disordered state of the body, such as to favor its growth—in other words, seed and a fertile soil; and if either is wanting, the disease is not produced. We never know when we may take in the germs on our food or in the air, hence we should see to it that we do not give them a fertile soil. "It is of primal consequence," says Dr. S. S. Burt, in a paper recently published in the New York Medical Record, "to elevate the tone of the tissues and the fluids that bathe them to a sanitary pitch, where they themselves are the best of germicides. Bacteria do not thrive upon such nourishment." While it is almost certain that the disease itself is not inherited, it is well established that a debased quality of blood and tissue, in which the germs of consumption find their proper food, is transmitted from parent to child. If both parents come from consumptive families their children have little chance of escaping the disease, but "a child with good blood for a legacy, even from one parent," says Dr. Burt, "has every reason to expect immunity from the disease, if he is reared intelligently. Such children must be properly clothed, very carefully fed, and encouraged to spend the greater part of their daily life in the open air."

Palm-wine.—Palm-wine is largely used as an alcoholic drink in India and other parts of Asia, the islands of the Pacific Ocean, Africa, and some parts of America. Most trees of the palm tribe contain a sap which is rich in sugar and is readily convertible into wine. This juice is collected by making cuts in the spathe or under the crown of leaves of the tree, and catching it in a cocoanut shell, gourd, or other vessel. The sugar is cane sugar, and is often prepared for itself. The richness of the juice is affected by the peculiarities of the species and of the tree, and its fermentability by the place of growth. The species used for wine are the oil-palm on the West Coast of Africa, the date-palm in northern Africa and India, the fan-palm and toddy-palm in India, the cocoa-palm in Ceylon and the islands of the Pacific, and the gommutti-palm in the Indian archipelago, the Moluccas, and the Philippines.

The Indians of Northwest Canada.—Dr. Boas, in the British Association Report on the Northwestern Tribes of the Dominion of Canada, describes the Indians of the Pacific coast as being able-bodied and muscular, with the upper limbs, owing to the strengthening of the arms and chest by the constant use of the paddle, generally better developed than the lower ones. They have a keen sight, but in old age frequently become blear-eyed. Their mental capacity is high, as is proved by the state of their culture. Whiteness of skin and slenderness of limbs are considered among the principal beauties of men and women, and long, black hair of women. In some of the tales red hair is described as a peculiar beauty of women Red paint on the face, tight-fitting bracelets and anklets of copper, nose and ear ornaments of variegated haliotis shells, and hair strewed with eagle-down, add to the natural charms. The fact that in honor of the arrival of friends the house is swept and strewed with sand, and that the people bathe at such occasions, shows that cleanliness is appreciated. The current expression is, that the house is so cleaned that no bad smell remains to offend the guest. For the same reason the Indian takes repeated baths before praying, "that he may be of agreeable smell to the deity." The Indian is grave and self-composed in all his actions; and playing is considered undignified and even bad. In the Tsimshian language the term for play means to talk to no purpose; and doing anything to no purpose is contemptible to the Indian. He is rash in anger, but does not easily lose control over his actions. He sits down or lies down sullenly for days without partaking of food, and when he rises his first thought is, not how to take revenge, but to show that he is superior to his adversary. Great pride and vanity, combined with the most susceptible jealousy, characterize all actions of the Indian. He watches that he may receive his proper share of honor at festivals; he can not endure to be ridiculed for even the slightest mistake; he carefully guards all his actions, and looks for due honor to be paid to him by friends, strangers, and subordinates. To be strong and able to sustain the pangs of hunger are evidently considered worthy of praise by the Indians; but foremost of all is wealth. It is considered the duty of every man to have pity upon the poor and hungry. Women are honored for their chastity and for being true to their husbands; children, for taking care of their parents; men, for skill and daring in hunting and for bravery in war.

Manual Training and the Brain.—In the discussion of Dr. Edward C. Kirk's paper on the Manual-training Idea as a Factor in Dental Education, in Philadelphia, Dr. J. L. Eisenbrey said that "the benefit to be derived from physical training means more than hand skill; it means the training of the brain man, the mental man; while you may show the effect of manual training in physical work, the result upon the brain does not come up until later on, lying back until the time calls for it; and you find that the men who occupy a conspicuous place, the young men in our profession, are the men who have had that training. To lay the foundation of a broad and complete education you need physical training, whether you get it in the city or country. I think that the country training is the best, from the simple fact that all over the whole land we find the places of trust in our banking institutions, the head places of our mechanical departments, and even in our schools of learning, filled by men who have been imported from the country, from the farm; who have handled the axe and the plow and the grubbing-hoe, who laid open the ditches and made of the swamps fruitful pastures. Physical training develops a good condition of physical health, and that means a healthful condition of the brain man; and, while it is a little slower, there comes a time when this healthful physical condition is shown in mental strength."

A Motherly Insect.—Among insects, as a rule, parents do not trouble themselves much about their little ones. They instinctively deposit their eggs in spots where the larvæ issuing from them will find a well-provided table, and then go away, leaving the larvæ to look out for themselves. Not so, says M. Albert Larbalétrier, in La Nature, with the earwigs. The female of this insect lays her eggs in the spring in bunches in a cool and dark place; then she sits on them, covering them in every way she can, leaving them only when she goes for food. If they get scattered she immediately finds it out, bestirs herself, looks about, and gathers them up, one by one, till she has got them together again. They hatch out during the first half of June. The larvæ are at first white, weak, imperfect in form, and hardly able to move. If left to themselves they would certainly perish very soon. The mother, however, does not leave them any more than she did her eggs; but she takes care of them, brings them food during their first days, and then guides them to the plants in the neighborhood. The little ones, too, as if aware of their weakness, do not wander away from their mother, and at the first sign of danger gather around her as chickens around a hen. The mother stays with the larvæ through all their moltings, till they are transformed into perfect insects, when she is taken away from them by death.

The Cherokee Theory of Disease.—The Cherokee doctor, according to Mr. James Mooney, in treating disease works to drive out a ghost or a devil. According to the Cherokee myth, disease was invented by the animals in revenge for the injuries inflicted upon them by the human race. The larger animals saw themselves killed and eaten by man, while the smaller animals, reptiles, and insects were trampled upon and wantonly tortured, until it seemed that their only hope of safety lay in devising some way to check the increase of mankind. The bears held the first council, but were unable to fix upon any plan of procedure, and dispersed without accomplishing anything. Consequently, the hunter never asks pardon of the bear when he kills one. Next the deer assembled, and, after much discussion, invented rheumatism, but decreed at the same time that if the hunter, driven by necessity to kill a deer, should ask its pardon according to a certain formula, he should not be injured. Since then, every hunter who has been initiated into the mysteries, asks pardon of the slain deer. When this is neglected, through ignorance or carelessness, the "Little Deer," the chief of the deer tribe, who can never die or be wounded, tracks the hunter to his home by the blood-drops on the ground, and puts the rheumatism spirit into him. Sometimes the hunter, on starting to return to his home, builds a fire in the trail behind him to prevent pursuit by the Little Deer. Later on, councils were held by other animals, birds, fishes, reptiles, and insects, each one inventing some new disease to inflict upon humanity, down even to the grub-worm, who became so elated at the bright prospect in view that in his joy he sprang into the air, but fell over backward and had to wriggle off on his back, as the grub-worm does to this day. When the plants, who were friendly to the human race, heard what had been done by the animals, they held a council, and each plant agreed to furnish a remedy for some corresponding disease when man should call upon it for help. While the great majority of diseases are thus caused by revengeful animal spirits, some are also caused by ghosts, witches, or violations of ceremonial regulations.

Instinctive Movements of Children.—M. Alfred Binet maintains, in the Revue Philosophique, that the attempts of infants to walk are instinctive, and not the result of education. This seems to be indicated by the more or less correlated movements which an infant only three weeks old will keep up if the soles of its feet are allowed to touch lightly a suitable surface. M. Binet believes that the time at which a child learns to walk depends, not on bodily conditions only, but on its mental characteristics also. He thinks he has established as a fact that a child that can give its mind to placing its steps, and whose attention is not easily distracted, learns to walk at an earlier age and in a shorter time than more restless children; and that such children are characterized in later life by the important faculty of close application to work. He remarks that the restless movements of young infants are almost always bilateral, though the two sides may be affected either synchronously or alternately. If an India-rubber ball connected with a tracing apparatus be placed in each hand of an intelligent child, and he be told to squeeze with one hand only, the tracing almost invariably shows that the ball had also been squeezed, but with less force, by the other hand. The "reaction time"—the interval between the giving of a signal and the performance of a prearranged movement—was found to be double that in healthy adults, and the duration of the contraction three times as long. M. Binet's observations indicate, against the conclusions of Mill and Bain, that our ideas of space are instinctive. A child three months old, who, the author is certain, had never had a fall, and was therefore without experience of its discomforts, would lie contentedly across a person's outstretched arms, if the hands were placed in such a position as to prevent its slipping down. If, however, the hands and arms were depressed, so that the infant would tend to slide down, it would show its fear by at once screaming and struggling.

Philosophy of Some Assassinations.—By the customs of some countries kings are not permitted to die natural deaths, but must be killed by their successors. An attempt to explain this usage is made by Mr. J. G. Fraser, in his Golden Bough. In primitive thought kings are credited with the possession of powers of the utmost importance and value to their worshipers. In Japan the existence of the globe and all that is upon it was supposed to depend upon the well-being of the Mikado. Yet kings or man-gods were subject to the law of death like ordinary mortals; and in the case of death the soul was believed to be extracted from the body by the wiles of a demon or sorcerer, or else voluntarily to go away never to return, and in either case to be lost, with all its virtues and benefits, to the worshipers. But if the soul could be caught in the act of escaping, and in full vigor, then it might still be kept present with the people. Hence the only way of security was to kill the man-god in order to make sure of catching his soul; and to kill him when in full vigor, in order that the soul might be transferred with all its energies unimpaired to the body of a suitable successor. "The people of Congo believed that if their pontiff, the Chitomé, were to die a natural death, the world would perish, and the earth, which he alone retained by his power and merit, would be immediately annihilated. Accordingly, when he fell ill and seemed likely to die, the man who was destined to be his successor entered the pontiff's house with a rope or a club and strangled or clubbed him to death. . . . In the kingdom of Unyoro, in central Africa, custom still requires that, as soon as the king falls seriously ill or begins to break down from age, he shall be killed by his own wives; for, according to an old prophecy, the throne will pass away from the dynasty in the event of the king dying a natural death." There are instances in which the king is allowed to reign only for a definite term, fixed independently of the signs of disease and decay, and at the end of which he is either killed by his successor or he immolates himself. Formerly the reign of the king of Calicut was thus limited to twelve years, after which he was obliged to cut his throat in public. Under a subsequent modification of the rule a great feast was made at the end of the appointed time, and, when this was over, any guest who, after fighting his way through the guards, succeeded in killing the king, was allowed to reign in his stead. "So long as the king could maintain his position by the strong hand, it might be inferred that his natural force was not abated; whereas his defeat and death at the hands of another proved that his strength was beginning to fail, and that it was time his divine life should be lodged in a less dilapidated tabernacle."

The Zungarian Desert.—The desert region called Zungaria, which lies on the western borders of Mongolia, rises to a height of about twenty-five hundred feet, but descends from it at many points. The soil is chiefly composed of the clay called loess, a mixture of very fine sand and a gray or yellowish calcareous earth. This argillaceous mass is pierced, like a sponge, by numerous tubes or pores, which are often lined with incrustations formed by herbaceous plants. The winds and the rain shape these deposits into abrupt, elevated, square-cut masses. This property of forming a kind of vertical cliffs, with the porous texture and the absence of stratification, are characteristic of the loess, as is also the presence of terrestrial or lacustrine remains instead of sea-fossils. Being exceedingly fine in constitution and well charged with certain salts, the loess is generally, when well irrigated, exceedingly fertile. In all the tillable regions of central Asia, including China, it plays the same part as the "black earth" of Russia. The mountains which form on the south the western border of Zungaria are rich in minerals. Gold is an important product of the region of Khotan, where there are twenty-two mines, some of them employing three or four thousand workmen. This region has long enjoyed the honor of being the only known place where nephrite or jade was found. The beds of that rare substance are in the district of Kárakach; but the quarrying for it has greatly fallen off since the disturbances that occurred during the brief reign of Yacoub Beg in Kashgar.

A Young Trader of the Solomon Islands.—It is amusing, says Mr. Woodford, in his Naturalist among the Head-hunters, to see a mere child paddle alongside in a crazy trough of a canoe, only just capable of supporting its weight. "The water splashes into the canoe at every stroke of the paddle, and at intervals the small child kicks it overboard with his foot—a novel kind of baler. Three or four moldy-looking yams, ostentatiously displayed, are rolling about in the water at the bottom of the canoe. The unsuspecting stranger takes pity on the tender years and apparent anxiety of the small native to trade, and gives him probably four times the price for his rusty yams. The child eagerly seizes the coveted stick of tobacco, and immediately stows it for safety through a hole in his ear, where at least it will be in no danger of getting wet. He next whisks aside a dirty-looking piece of matting that has apparently got accidentally jammed in one end of the canoe, and displays some more yams, of a slightly better quality than the last. For the sake of consistency you can not well offer him less than you did before, and another stick of tobacco changes hands and is transferred to the other ear. You think now that he must have finished, as there is no place in the canoe to hide anything else, but with a dexterous jerk that nearly upsets the canoe he produces a single yam that he has been sitting upon. How it managed to escape notice before is a puzzle. For this he demands a pipe, but is not satisfied with the first or second that is shown him. No; he must have a *piala tinoni*, or have his yam back. The *piala tinoni* is a pipe with a man's face upon the bowl. But again the young trader is particular; it must also have a knob at the bottom, or he will have none of it."

Population of Cheese.—M. Adametz, of Somthal, Switzerland, has been making a census of the microscopic animalcules in cheese. In the fresh cheese of Emmenthal he finds from 90,000 to 140,000 microbes to a gramme, the number increasing with time—a cheese 71 days old had 800,000 to the gramme. The population of mild cheese (*fromage mou*) was still more dense. At 25 days of age it was 1,200,000; at 45 days, 200,000,000 microbes per gramme. These figures apply to the middle of the cheese, while the population is much more dense toward the outside, where it rises to from 3,600,000 to 5,600,000. At this rate, the number of living beings in 360 grammes of cheese is as great as the number of men on the globe.

Green Seeds and Early Fruit.—Correspondents of Garden and Forest remark upon the evidence afforded by recent experiments that seeds from immature fruit will give a product requiring less than the usual time to ripen, and that the earliness thus gained can be increased by continuing the selection. This has been observed, according to Dr. E. Lewis Sturtevant, at the New York Experiment Station, in the case of varieties of corn, turnip, and cabbage. At Purdue University, Indiana, a gain of from fifteen to twenty days has been obtained by early selection. Prof. Arthur, of Purdue University, has observed further that the plant as well as the fruit thus cultivated tends to early ripeness, and hence the period of fruitfulness, or the time between the first and the last ripe fruit, is much shortened. With the increase in the amount of fruit, according to Prof. Arthur, there is also a corresponding decrease in the size of the vegetative parts of the plant—that is, the stems and foliage. A tomato plant grown from green seed in the fourth generation was found to bear three and a fourth times as much fruit as top or stems and leaves together, while a similar plant from ripe seed had only one and an eighth times as much fruit as tops. It follows that, while earliness may be considered as a usual condition in all crops from unripe seed, an increase in the amount of the crop occurs only when the true fruit is the part harvested, as in tomatoes and peas, and a decrease in the amount of the crop occurs when any part besides the fruit is harvested, as in turnips and potatoes.

Imitative Coloring of Animals and Plants.—Among the later papers by Mr. Proctor in "Knowledge" is a study of color-mimicry in animals and flowers. It was suggested by observing a chameleon among the green leaves of an ivy, where it was as green as they. A fly of nearly similar color came along, and was instantly caught by the animal's nimble tongue. Afterward the chameleon settled on one of the sticks supporting the ivy, "and there it gradually assumed the same color, so far harmonizing with the stick that he seemed only an excrescence upon it, not a live creature which a short time before had been light green in color." This incident suggests some other illustrations of various forms in which color affects the development of life. Consider, continues Mr. Proctor, the striped tiger as an example of color in an animal that lives by preying on others, and the zebra as an example of color in an animal whose life depends on its not becoming the prey of carnivorous animals. "We can understand how, in certain regions, those members of feline races who chanced to have markings on their bodies which corresponded in appearance with the stems of trees, or with jungle reeds, and the like, would be better able to remain concealed till the animals which formed their prey came within certain range of their spring, and so would have the best chances of living"; and in like manner it is manifestly to the advantage of the zebra, when sleeping in the shade of trees, "to have markings on his body which from a distance would be confounded with the stems of trees and shrubs, beneath which for a while his active limbs were at rest. For so would he best escape the attacks of animals of prey. It is noteworthy that, when the zebra is stretched on the ground, the stripes on his legs as well as those on his body are vertical as seen from a distance. The same is the case in the tiger's stripes when the animal is couched for a spring." Another topic for speculation is the persistency of these imitative characteristics, which often appear as sports in the descendants of these animals ages after the purpose of their adaptation has ceased to exist. The author's attention was directed, while he was writing, to a sandy-colored cat "marked with stripes such as hundreds of thousands of years ago were of value to its remote ancestors in the struggle for life"; and a mule plowing in a field near his house had rings around his legs precisely corresponding to rings on the same parts in the zebra. In the vegetable world, color seems to be in all cases dependent on the requirements of propagation. Thus, where seeds are diffused by animals, as with the berries, we find the fruits brightly colored, to attract the attention of the animal distributors. It will be noticed that, when seeds are distributed by the winds, bright colors are not found in the fruit, even though the plant be closely allied to species distributed by animals in which the bright colors are present.

Bristling with Fire.—Photographic pictures of the smoke issuing from the mouth of a cannon at the moment it is fired show thin trails of fire about the circumference of the smoke-cloud, which give its edge the appearance of a porcupine's back bristling with quills. The trails are caused by the ignition of cubes of the pebble-powder which have been shot from the gun before the combustion was completed. Prof. W. Mattieu Williams has found, by examining the papers of Count Rumford, that he made experiments on the same subject, from which he inferred that in the ordinary firing of gunpowder in firearms the explosion must be gradual. In using powder in grains and cubes of sizes proportioned to the caliber of their guns, modern artillerists are only carrying out the principles which Rumford expounded. He foretold the danger of firing such artillery as we now use with ordinary small-grain powder. Such powder would explode completely before the shot could fairly be set in motion, and would produce bad effects on the gun. The modern cubes burn on their surface and thereby start the ball. They continue burning and evolving more and more gas as the ball travels along the tube, and, to be perfect, should just complete their combustion as it leaves the mouth of the gun. But this degree of perfection is not attained, and hence we have the "porcupine-quills" appearance.

Horse-Sausages.—The best Bologna sausages are made of chopped bacon and pea-flour, and are flavored chiefly with garlic and cloves. When the bacon is old, but sound, says the Sanitarian, such sausages are wholesome and highly nutritious, and are especially useful to laborers, travelers, and soldiers in camp, and others who have not the means of cooking at hand. They rarely spoil, but, being eaten uncooked, they may sometimes introduce trichinæ. The use of horse-flesh is a recent innovation in sausage manufacture, and is practiced in Italy and Belgium, as well as in this country. These horse-sausages are said to be of the Bologna variety, and the makers justify them from the wholesomeness of horse-flesh when healthy. But the meat actually used is that of animals worn out by work or made useless by disease—"fit for nothing else."

The Médoc Wines.—The Médoc district of France, famous for its wines, consists of a long strip of land, extending northerly from Bordeaux and lying between the sea and the river Gironde. The best vines are grown on a surface of gravel-quartz and sand with a clay subsoil. The vine most usually grown is of a stunted variety, and seldom rises more than two feet from the ground. They first bear about five years after being planted, and continue productive for one hundred or even two hundred years. The grapes, when taken to the press-house, are stripped from the stalks and placed in large vats, some of which have a capacity of 3,240 gallons apiece. In these they are left to ferment for a period of from a week to a fortnight, after which the wine is drawn off into hogsheads and taken to cool in well-ventilated stores. Here the casks are filled up at intervals, and the drawings-off are attended to at the proper time. Tendency to excessive fermentation is checked by drawing the wine off into casks impregnated with sulphur. The Médoc wines are classified into several grades or growths, the qualities of which are considerably capricious; and the quantity of wine produced at the several vineyards is subject to great fluctuations. Notwithstanding, however, the uncertainty of the annual return, the Médoc district is said to be of greater commercial value to France than both the better known Cognac and Champagne districts put together.

NOTES.

In respect to the use of the diamond drill, or an instrument of corresponding effectiveness, by the ancient Egyptians, Mr. W. F. Durfee, having inquired through our consul-general at Cairo, received from Mr. W. Flinders Petrie the following list of objects in which marks of such an instrument may be seen: Base of tube-drill hole, cut too deep in roughing out the statue, between the feet of the diorite statue of Chafra (Kofra), in the Boulak Museum; sides of two drill-holes, showing on the inside of the sarcophagus at Gizeh; the marks are near the top, at the north end of the east side, and on the west end; saw-cut too deep into the outside of that sarcophagus, on the north end, near the top at the northeast edge; saw-cut surface beneath the sarcophagus in the second pyramid at Gizeh; drill-hole with core sticking in it, in the granite lintel of the chamber leading from the southwest corner of the great hall of the granite temple of Gizeh, the fifth hole. Mr. Petrie believes there are some small drill-holes in the Hyksos head in black granite from Bubastis, in the Boulak Museum, where the eye-sockets have been cut out.

The importance of taking care of the first teeth is insisted on by Mr. Fisher, a dentist of Dundee. While they are destined to disappear in a short time and give place to other teeth, they will cause pain and general conditions of disease if they are unsound, the same as the permanent teeth do; and the latter can not escape being affected by the disorders they occasion. It is not safe to depend on extracting them if they cause pain, for that enfeebles the chewing power; and, if many of them are removed, the jaw does not develop properly, and the second teeth are made liable to grow irregularly.

The respiration of insects has been the subject of study by M. Contejean, who has found that, contrary to what takes place in vertebrates, the movement of inspiration is passive and that of expiration active. The air is driven from the body by a contractile effort. Hence, when the insect is wounded, the flow of blood occurs at each expiration. The respiratory movement is not interrupted by cutting off the head, nor by the absorption of curare, whch produces an immediate cessation in man.

Dr. G. Meyer thinks that he is able to assume, from a comparison of the records of a number of years, that the moon has an influence in lowering the height of the barometer in the months from September to January, at the time of full moon, and in raising it during the first quarter. His views are confirmed by the independent studies of Captain Seemann, of the Deutsche Seewarte. No effect has been perceived in the other months.

The property marking bacteria and bacilli of absorbing aniline and being killed by it has been put to good use by two German observers, Messrs. Stilling and Wortmann. Having demonstrated that the violet aniline dyes, without arsenic, were not poisonous to rabbits and guinea-pigs, the authors produced eye-disorders in those animals, and treated them successfully with aniline. They then tried the human subject, and cured a skin-ulcer on a scrofulous child, by daily dropping a little aniline solution on the sore. Similar good results were had with bad cases of eye disease; and it soon appeared that many surgical cases were open to treatment in this way, and that, in general, wounds and sores developing suppuration could be sterilized with aniline. It is thought that cases of internal inflammation may also be within reach of this treatment.

Pensions have been granted in the English civil list to Dr. Huggins, the widow of the Rev. J. G. Wood, and the four unmarried daughters of the late Rev. M. J. Berkeley.

Mr. G. W. Hambleton regards consumption as depending on conditions that reduce the breathing surface of the lungs below a certain proportion to the rest of the body. The conditions include sedentary overcrowding, want of exercise, defective seats, ill-fitting clothes, and whatever may impair the lungs or lead to undue compression of the chest. Remedies should be sought in free country life, well-ventilated rooms, suitable chairs, and clothing free from constriction and not too heavy The earliest physical training should aim at the full development of the thorax. Persons whose breathing capacity does not measure up to the normal should not engage in any occupation tending to constrain the chest or to expose the lungs to the inhalation of dust.

Prof. F. W. Oliver has published a paper on the floral biology of the flower *Episcia maculata*, a plant which, recently sent over from British Guiana, first flowered at Kew last summer. It is remarkable in that the flowers are never open, but the front lobe of the corolla is from the first folded back, so as to close the mouth like a cork. Nevertheless, all the arrangements are such as are adapted for cross-fertilization by the agency of some insect. The plant is unique in being at once closed and yet requiring the visit of an insect for its fertilization.

Advantage is to be taken of the height of the Eiffel Tower to fix in it a manometric tube in which mercury can be poured to form a column that will give a pressure of four hundred atmospheres. M. Cailletet hopes to be able to make use of this enormous pressure in continuing his experiments on the liquefaction of gases.

A deposit of floridite, or phosphate of lime, described by Prof. E. T. Cox as found in Florida, occurs in beds from a few feet to thirty-seven or more feet deep at places, over an area of 120 miles north and south, and 20 miles east and west, and consists of 80 per cent pure phosphate. The author believes that it is derived from the mineralization of an ancient guano.

The crumpled and crushed form of the human ear is accounted for by Prof. H. D. Garrison as a result of the habit of lying on the side of the head, which habit has been induced by the increasing weight of the brain. The question, says the author, in his paper on the subject, read at the American Association, had originally been whether the animals through which it had been developed would profit most by large brains or by perfect and symmetrical hearing apparatus, and had been promptly decided by natural selection in favor of large brains.

The Biological Section of the American Association has approved of a movement to establish a biological station on the Gulf of Mexico, for which subscriptions of $25,000 have been promised. The station will probably be located at Tarpon Springs, Fla., where there are fine opportunities for the study of fresh and salt water, as well as of land forms.

Dr. William Huggins has been chosen to be President of the next year's meeting of the British Association to be held in Cardiff, Wales. The meeting of the Association in 1892 will be held in Edinburgh.

Prof. A. J. Cook, speaking of the Food of Bees, remarks that the carbohydrates are sufficient for the life of the insects, but that they must have nitrogenous food to support them during the process of reproduction. The former they derive from the honey of plants, the latter from spores, grain, fungi, and bee-bread.

Concerning certain philological and ethnological discussions that are going on with considerable warmth, Mr. John Evans said, in his address in the British Association, that it will be for the benefit of science for speculations as to the origin and home of the Aryan family to be rife; but it will still more effectually conduce to our eventual knowledge of this most interesting question if it be consistently borne in mind that they are but speculations.

An important manufacture of butter from cocoanut-milk is growing up in Germany. Cocoanuts for the purpose are imported in large numbers from India.

Recent investigations by Prof. Geddes, of Edinburgh, have led him to reject the commonly accepted views of the origin of thorns. He has found that there is a more or less developed general contrast in vegetative habit between thornless and thorny varieties. The thorny varieties or species show a more diminishing vegetativeness than their thornless congeners; in fact, they frequently develop their thorns by the actual death of their germ points.

The presidential address of Prof. T. E. Thorpe, in the Chemical Section of the British Association, was largely devoted to the vindication of the claims of Priestley to be the discoverer of oxygen and of the non-elementary nature of water, against the attempt of M. Berthelot, in his Révolution Chimique, to appropriate a principal share in the discoveries to Lavoisier.

A notion has been put forth by the editor of a leading dairy paper that neither dipping out milk nor drawing it through a faucet from large cans gives portions of equal quality to every customer. The dipping method was tested, at Cornell, on three milk routes—the conclusion reached being that by this practice "substantial justice is done all the patrons so far as the amount of fat apportioned to each is concerned."

OBITUARY NOTES.

Sir Richard F. Burton, who died at Trieste, Austria, October 30th, was one of the most venturesome travelers and explorers and voluminous authors of modern times. He was born in Hertfordshire, England, in 1821. Having no taste for the university, he entered the East India and afterward the British diplomatic service. He visited the holy places of Arabia and won fame by the book he wrote about them; was the first European to visit Herat; discovered Lake Tanganyika; traveled to Salt Lake City and California; spent three or four years in western Africa; explored the Brazilian highlands and Paraguay; spent two vacations in "unexplored Syria"; visited Iceland; explored the land of Midian; and accompanied Cameron to the Gold Coast. His published works approach eighty volumes, of which thirty-nine are accounts of travel and exploration. Of these the Lake Region of Equatorial Africa is one of the best books on Africa. Burton also published grammars of three Oriental languages, five volumes of folk-lore, three books on fencing, and translations of the Portuguese poet Camoëns, and of the Arabian Nights.

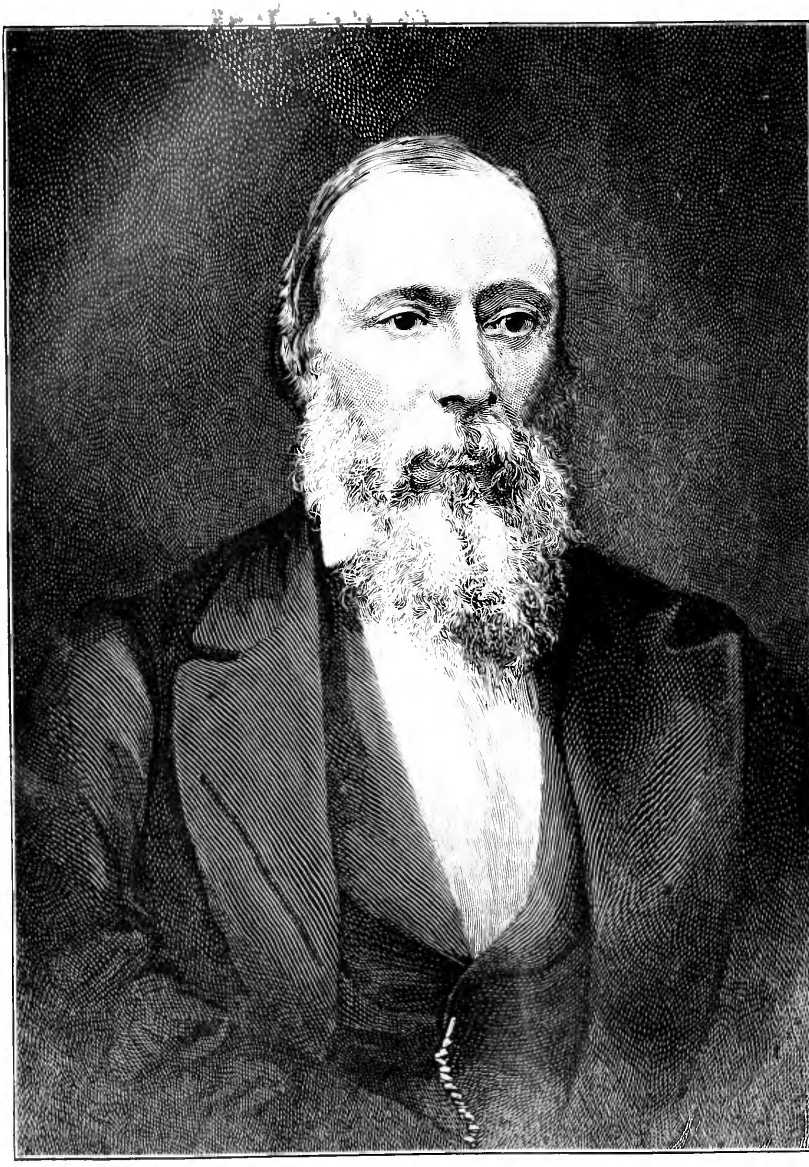
Mr. John Hancock, an English ornithologist, died at his home in Newcastle-on-Tyne, October 11th, at the age of eighty-nine years.

The death is announced of Dr. Wenzel Leopold Gruber, Professor of Anatomy in the University of St. Petersburg. He was seventy-six years old.

Prof. Thorold Rogers, the eminent English economist, has recently died at Oxford. He was educated at King's College, London, and at Oxford, and began life as a clergyman of the Puseyite school. He afterward became a "coach" at Oxford, where he wrote a hand-book on Education and a pamphlet on the Law of Settlement. He was made Professor of Political Economy at Oxford in 1862, after which he devoted himself mainly to economical subjects, and entered Parliament in 1880. He published two volumes of Historical Sketches; Cobden and Modern Political Opinion; Agriculture and Prices in England (his most important work); Six Centuries of Work and Labor; The Economical Interpretation of History; and the History of Holland in the Story of the Nations series.

Mr. Robert Brough Smyth, of Victoria, Australia, who died in August last, had an important part in the scientific work of the colonies. He was from 1855 to 1858 Director of Meteorological Observations for the Colony of Victoria; was for some years member and Secretary of the Board of Science; honorary secretary and member of the Board for the Protection of Aborigines; Director of the Geological Survey of the Colony; and author of many works and papers on geology, ethnology, and philology.

Captain John Page, of the Argentine Navy, a summary of whose lecture on the Gran Chaco and its rivers has been published in the Monthly, died in June or July while making an attempt to explore the Pilcomayo River at about one hundred and fifty leagues from its mouth. The expedition reached the mouth of the river in the small steamer General Paz in April last, and Captain Page attempted the ascent thence in a vessel built especially for the service, drawing only eight inches of water; but even then the ascent was found impracticable, and the steamer could often be kept afloat only by damming up the stream.



JEAN CHARLES HOUZEAU.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XI. FROM BABEL TO COMPARATIVE PHILOLOGY.

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PART II.

IN the first part of this article we saw the steps by which the sacred theory of human language had been developed; how it had been strengthened in every land until it seemed to bid defiance forever to secular thought; how it rested firmly upon the letter of Scripture, upon the explicit declarations of leading fathers of the Church, of the great doctors of the middle ages, of the most eminent theological scholars down to the beginning of the eighteenth century, and was guarded by the decrees of popes, bishops, Catholic and Protestant, kings, and the whole hierarchy of authorities in church and state.

And yet, as we now look back, it is easy to see that, even in that hour of its triumph, it was doomed.

The reason why the Church has so fully accepted the conclusions of science which have destroyed the sacred theory is instructive. The study of languages has been, since the revival of learning and the Reformation, a favorite study with the whole Western Church, Catholic and Protestant. The importance of understanding the ancient tongues in which our sacred books are preserved first stimulated the study, and church missionary efforts have contributed nobly to supply the material for extending it, and for the application of that comparative method which, in philology as in other sciences, has been so fruitful of good. Hence it is that so many leading theologians have come to know at first hand the truths given by this science, and to recognize its fundamental principles. What the conclusions which they, as well as all other scholars in this field, have been absolutely forced to accept, I shall endeavor to show in this chapter.

The beginnings of a true and scientific theory seemed weak indeed, but they were none the less effective. As far back as 1661, Hottinger, professor at Heidelberg, came into the chorus of theologians like a great bell in a chime; but like a bell whose opening tone is harmonious, and whose closing tone is discordant. For while, at the beginning, Hottinger cites a formidable list of great scholars who had held the sacred theory of the origin of language, and here was in harmony with the chorus, he goes on to note a closer resemblance to the Hebrew in some languages than in others, and explains this by declaring that the confusion of tongues was of two sorts, total and partial: the Arabic and Chaldaic he thinks underwent only a partial confusion; the Egyptian, Persian, and all the European languages a total one: here comes in the discord; here gently sounds forth from the great chorus a new note—that idea of grouping and classifying languages which at a later day was to destroy utterly the whole sacred theory.

But the great chorus resounded on, as we have seen, from shore to shore, until the closing years of the seventeenth century; then arose men who silenced it forever. The first leader who threw the weight of his knowledge, thought, and authority against it was Leibnitz, the rival of Isaac Newton. He declared, "There is as much reason for supposing Hebrew to have been the primitive language of mankind as there is for adopting the view of Goropius, who published a work at Antwerp in 1580 to prove that Dutch was the language spoken in paradise." In a letter to Tenzel, Leibnitz wrote, "To call Hebrew the primitive language is like calling the branches of a tree primitive branches, or like imagining that in some country hewn trunks could grow instead of trees." He also asked very cogently, "If the primeval language existed even up to the time of Moses, whence came the Egyptian language?"

But the efficiency of Leibnitz did not end with mere suggestions. He applied the inductive method to linguistic study, and made great efforts to have vocabularies collected and grammars drawn up wherever missionaries and travelers came in contact with new races. He thus succeeded in giving the initial impulse to at least three notable collections—that of Catharine the Great, of Russia; that of the Spanish Jesuit, Lorenzo Hervas; and, at a later period, the Mithridates of Adelung. The interest of the Empress Catharine in her collection of linguistic materials was very strong, and her influence is seen in the fact that Washington, to please her, requested governors and generals to send in materials from various parts of the United States and Territories. The work of Hervas extended over the period from 1735 to 1809;

a missionary in America, he enlarged his catalogue of languages to six volumes, which were published in Spanish in 1800. His work contained specimens of more than three hundred languages, and the grammars of more than forty. It should be said to his credit that Hervas dared point out with especial care the limits of the Semitic family of languages, and declared, as a result of his enormous studies, that the various languages of mankind could not have been derived from the Hebrew.

While such work was done in Catholic Spain, Protestant Germany was honored by the work of Adelung. It contained the Lord's Prayer in nearly five hundred languages and dialects, and the comparison of these early in the nineteenth century helped to end the sway of Scriptural philology.

But the period which intervened between Leibnitz and this modern development was a period of philological chaos. It began mainly with the doubts which Leibnitz had forced upon Europe, and the end of it only began with the study of Sanskrit in the latter half of the eighteenth century, followed by the comparisons made by means of the collections of Catharine, Hervas, and Adelung at the beginning of the nineteenth. The old theory that Hebrew was the original language had fallen into disrepute, but nothing had taken its place as a finality. Great authorities, like Buddeus, were still cited in behalf of the narrower belief, but everywhere researches, unorganized though they were, tended to destroy it. The story of Babel continued indeed throughout the whole eighteenth century to hinder or warp scientific investigation, and a very curious illustration of this fact is seen in the book of Lord Nelme on The Origin and Elements of Language. He declares that the incident of the confusion was the cleaving of America from Europe, and regards the most terrible chapters in the Book of Job as intended for a description of the flood, which in all probability he had from Noah himself. Again, Rowland Jones tried to prove that Celtic was the primitive tongue, and that it passed through Babel unharmed. Still another effort was made by a Breton to prove that all languages took their rise in the language of Brittany. All was chaos. The old theory had gone to pieces, but no new theory had yet been formed. There was much wrangling, but little earnest controversy. Here and there theologians were calling out frantically, beseeching the Church to save the old doctrince as "essential to the truth of Scripture"; here and there other divines began to foreshadow the inevitable compromise which has always been thus vainly attempted in the history of every science. But it was soon seen by thinking men that no concessions as yet spoken of by theologians were sufficient. In the latter half of the century came the bloom period of the French philosophers and encyclopedists, of the English deists, of such German thinkers as Herder, Kant, and Lessing; and while here and there some writer on the theological side, like Perrin, amused thinking men by his flounderings in this great chaos, all remained without form and void.*

Nothing reveals to us better the darkness and duration of this chaos in England than a comparison of the articles on Philology given in the successive editions of the Encyclopædia Britannica. The first edition of that great mirror of British thought was printed in 1771; chaos reigns through the whole of its article on this subject. The writer divides languages into two classes, seems to indicate a mixture of divine inspiration with human invention, and finally escapes under a cloud. In the second edition, published in 1780, some progress has been made. The author states the sacred theory, and declares: "There are some divines who pretend that Hebrew was the language in which God talked with Adam in paradise, and that the saints will make use of it in heaven in those praises which they will eternally offer to the Almighty. These doctors seem to be as certain in regard to what is past as to what is to come."

This was evidently considered dangerous. It clearly outran the good sound belief of the average English Philistine; and accordingly we find in the third edition, published seventeen years later, a new article, in which, while the author gives, as he says, "the best arguments on both sides," he takes pains to adhere to a fairly orthodox theory.

This soothing dose is repeated in the fourth and fifth editions. In 1824 appeared a supplement to the fourth, fifth, and sixth editions, and this deals with the facts so far as they are known. There is scarcely a reference to the biblical theory throughout the article; and the author refers rather contemptuously to it. Three years later comes another supplement. While this Chaos was fast becoming Cosmos in Germany, such a change had evidently not gone far in England, for from this edition of the Encyclopædia the subject of philology is omitted. In fact, Babel and Philology made nearly as much trouble to encyclopedists as

* For Hottinger, see the preface to his Etymologicum Orientale, Frankfort, 1661. For Leibnitz, Catharine the Great, Hervas, and Adelung, see Max Müller, as above, from whom I have quoted very fully. See also Benfey, Geschichte der Sprachwissenschaft, etc., p. 269. Benfey declares that the Catalogue of Hervas is even now a mine for the philologist. For the first two citations from Leibnitz, as well as for a statement of his importance in the history of languages, see Max Müller, as above, pp. 135, 136. For the third quotation, Leibnitz, Opera, Geneva, 1768, vi, Part. II, 232. For Nelme, see his Origin and Elements of Language, London, 1772, pp. 85–100. For Rowland Jones, see The Origin of Language and Nations, London, 1764, and preface. For the Origin of Languages in Brittany, see Le Brigaut, Paris, 1787. For Herder and Lessing, see Canon Farrar's Treatise; on Lessing, see Sayce, as above. As to Perrin, see his essay Sur l'Origine et l'Antiquité des Langues, London, 1767.

Noah's Deluge and Geology. Just as in the latter case they had been obliged to stave off a presentation of scientific truth, by the words "For Deluge, see Flood," and "For Flood, see Noah," so in the former they were obliged to take various provisional measures—some of them comical. In 1842 came the seventh edition. In this the first part of the old article on philology which appeared in the third, fourth, and fifth editions was printed, but the supernatural part was mainly cut out. Yet we find a curious evidence of the continued reign of chaos in a foot-note inserted by the publishers, disavowing any departure from orthodox views. In 1859 appeared the eighth edition. This abandoned the old article entirely, and in its place was given a history of philology free from admixture of scriptural doctrines; and, finally, in the year 1885 appeared the ninth edition, in which Professors Whitney of Yale and Sievers of Tübingen give admirably and in short compass what is known of philology, throwing the sacred theory overboard entirely.

Such was that chaos of thought into which the discovery of Sanskrit suddenly threw its great light. Well does one of the foremost modern philologists say that this "was the electric spark which caused the floating elements to crystallize into regular forms." Among the first to bring the knowledge of Sanskrit to Europe were the Jesuit missionaries, whose services to the material basis of the science of comparative philology had already been so great, and the importance of the new discovery was soon seen among all scholars, whether orthodox or scientific. In 1784 the Asiatic Society at Calcutta was founded, and with it began Sanskrit philology. Scholars strong and earnest, like Sir William Jones, Carey, Wilkins, Foster, Colebrooke, did noble work in the new field. Light had come into the chaos, and a great new orb of science was steadily evolved.

The little group of scholars who gave themselves up to these researches, though almost without exception reverent Christians, were recognized at once by theologians as mortal foes of the whole old sacred theory of language. Not only was the dogma of the origin of languages at the Tower of Babel swept out of sight by the new discovery, but the still more vital dogma of the divine origin of languages, never before endangered, was felt to be in peril, since the evidence became overwhelming that so large a number of them had been produced by a process of natural growth.

Heroic efforts were therefore made, in the supposed interest of Scripture, to discredit the new learning. Even such a man as Dugald Stewart declared that the discovery of Sanskrit was altogether fraudulent, and endeavored to prove that the Brahmans had made it up from the vocabulary and grammar of Greek and

Latin. Others exercised their ingenuity in picking the new discovery to pieces, and still others attributed it all to the machinations of Satan.

On the other hand, the more thoughtful men in the Church endeavored to save something from the wreck of the old system by a compromise. They attempted to prove that Hebrew is at least a cognate tongue with the original speech of mankind, if not the original speech itself; but here they were confronted by the authority whom they dreaded most, the great Christian scholar, Sir William Jones himself. His words were: "I can only declare my belief that the language of Noah is irretrievably lost. After diligent search I can not find a single word used in common by the Arabian, Indian, and Tartar families, before the intermixture of dialects occasioned by the Mohammedan conquests."

So, too, in Germany came full acknowledgment of the new truth, and from a man won over to the Roman Catholic Church, Frederick Schlegel. He accepted the discoveries in the old language and literature of India as final: he saw the significance of these discoveries as regards philology, and grouped the languages of India, Persia, Greece, Italy, and Germany under the name afterward so universally accepted—Indo-Germanic.

It now began to be felt more and more, even among the most devoted churchmen, that the old theological dogmas regarding the origin of language, as held "always, everywhere, and by all," were wrong, and that Lucretius and sturdy old St. Gregory of Nyssa were right.

But this was not the only wreck. During ages the great men in the Church had been calling upon the world to wonder over the amazing exploit of Adam in naming the animals which Jehovah had brought before him, and to accept the history of language in the light of this exploit. The early fathers, the mediæval doctors, the great divines of the Reformation period, Catholic and Protestant, had united in this universal chorus. Clement of Alexandria declared Adam's naming of the animals proof of a prophetic gift. St. John Chrysostom insisted that it was an evidence of consummate intelligence. Eusebius held that the phrase "that was the name thereof" implied that each name embodied the real character and description of the animal concerned.

This view was echoed by a multitude of divines in the seventeenth and eighteenth centuries. Typical among these was the great Dr. South, who, in his sermon on The State of Man before the Fall, declared that "Adam came into the world a philosopher, which sufficiently appears by his writing the nature of things upon their names."

In the chorus of modern English divines there appeared one of eminence who declared against this theory: sturdy old Dr. Shuckford, chaplain in ordinary to his Majesty George II, in the preface to his work on The Creation and Fall of Man, pronounced the whole theory "romantic and irrational." He goes on to say: "The original of our speaking was from God; not that God put into Adam's mouth the very sounds which he designed he should use as the names of things; but God made Adam with the powers of a man; he had the use of an understanding to form notions in his mind of the things about him, and he had the power to utter sounds which should be to himself the names of things according as he might think fit to call them."

This echo of Gregory of Nyssa was for many years of little avail. Historians of philosophy still began with Adam, because only a philosopher could have named all created things. There was, indeed, one difficulty which had much troubled some theologians; this was, that fishes were not specially mentioned among the animals brought by Jehovah before Adam for naming. To meet this difficulty there was much argument, and some theologians laid stress on the difficulty of bringing fishes from the sea to the garden of Eden to receive their names; but naturally other theologians replied to this that the almighty power which created the fishes could have easily brought them into the garden, one by one, even from the uttermost parts of the sea. This point, therefore, seems to have been left in abeyance.*

It had continued, then, the universal belief in the Church that the names of all created things, except possibly fishes, were given by Adam and in Hebrew; but all this theory was whelmed in ruin when it was found that there were other and, indeed, earlier names for the same animals than those in the Hebrew language; and especially was this enforced on sincere and thinking men when the Egyptian discoveries began to reveal the pictures of animals with their names in hieroglyphics at a period earlier than that agreed on by all the sacred chronologists as the date of the creation.

Still another part of the sacred theory now received its deathblow. Closely allied with the question of the origin of language was the origin of letters. The earlier writers had held that let-

* For the danger of "the little system of the history of the world," see Sayce, as above. On Dugald Stewart's contention, see Max Müller, Lectures on Language, pp. 167, 168. For Sir William Jones, see his Works, London, 1807, Part III, p. 199. For Schlegel, see Max Müller, as above. For an enormous list of great theologians from the fathers down, who dwelt on the divine inspiration and wonderful gifts of Adam on this subject, see Canon Farrar, Language and Languages. The citation from Clement of Alexandria is Strom. i, p. 335. See also Chrysostom, Hom. XIV in Genesin. Also, Eusebius, Præp. Evang. XI, p. 6. For the two quotations above given from Shuckford, see The Creation and Fall of Man, London, 1763, preface, p. lxxxiii; also his Sacred and Profane History of the World, 1753; revised edition by Wheeler, London, 1858. For the argument regarding the difficulty of bringing the fishes to be named into the garden of Eden, see Massey, Origin and Progress of Letters, London, 1763, pp. 14–19.

ters were also a divine gift given to Adam; but as we go on in the eighteenth century we find theological opinion inclining to the belief that this gift was reserved for Moses. This, as we have seen, was the view of St. John Chrysostom; and an eminent English divine early in the eighteenth century, John Johnson, Vicar of Kent, echoed it in the declaration concerning the alphabet, that "Moses first learned it from God by means of the lettering on the tables of the law." But here a difficulty arose: the biblical statement that God commanded Moses to "write in a book as decreed concerning Amalek" before he went up into Sinai. With this the good vicar grapples manfully. He supposes that God had previously concealed the tables of stone in Mount Horeb, and that Moses, "when he kept Jethro's sheep thereabout, had free access to these tables, and perused them at discretion, though he was not permitted to carry them down with him." Our author then asks for what other reason could God have kept Moses up in the mountain forty days at a time, except to teach him to write; and says, "It seems highly probable that the angel gave him the alphabet of the Hebrew, or in some other way unknown to us became his guide."

But this theory of letters was soon to be doomed like the other parts of the sacred theory. Studies in Comparative Philology based upon researches in India, began to be re-enforced by facts regarding the inscriptions in Egypt, the cuneiform inscriptions of Assyria, the legends of Chaldea, and the folk-lore of China, where it was found in their sacred books that the animals were named by Fohi, and with such wisdom and insight that every name disclosed the nature of the corresponding animal.

But, although the old theory was doomed, heroic efforts were still made to support it. In 1788 James Beattie, in all the glory of his Oxford doctorate and royal pension, made a tremendous onslaught, declaring the new system of philology to be "degrading to our nature." He says that the theory of the natural development of language is simply due to the beauty of Lucretius' poetry. But his main weapon is ridicule, and in this he shows himself a master. He tells the world, "The following paraphrase has nothing of the elegance of Horace or Lucretius, but seems to have all the elegance that so ridiculous a doctrine deserves":

"When men out of the earth of old
A dumb and beastly vermin crawled;
For acorns, first, and holes of shelter,
They tooth and nail, and helter skelter,
Fought fist to fist; then with a club
Each learned his brother brute to drub;
Till, more experienced grown, these cattle
Forged fit accoutrements for battle.

At last (Lucretius says and Creech)
They set their wits to work on *speech:*
And that their thoughts might all have marks
To make them known, these learned clerks
Left off the trade of cracking crowns,
And manufactured verbs and nouns."

But a far more powerful theologian entered the field in England to save the sacred theory of language—Dr. Adam Clarke. He was no less severe against Philology than against Geology. In 1804, as President of the Manchester Philological Society, he delivered an address in which he declared that, while men of all sects were eligible to membership, "he who rejects the establishment of what we believe to be a divine revelation, he who would disturb the peace of the quiet, and by doubtful disputations unhinge the minds of the simple and unreflecting, and endeavor to turn the unwary out of the way of peace and rational subordination, can have no seat among the members of this institution." The first sentence in this declaration gives food for reflection, for it is the same confusion of two ideas which has been at the root of so much interference of theology with science for the last two thousand years. Adam Clarke speaks of those "who reject the establishment of what '*we believe*' to be a divine revelation." Thus comes in that customary begging of the question—the substitution as the real significance of Scripture of "*what we believe*" for what *is*.

The intended result, too, of this ecclesiastical sentence was simple enough. It was, that great men, like Sir William Jones, Colebrooke, and their compeers, must not be heard in the Manchester Philological Society in discussion with Dr. Adam Clarke on questions regarding Sanskrit and other matters upon which they knew all that was then known, and Dr. Clarke knew nothing.

But even Clarke was forced to yield to the scientific current. Thirty years later, in his Commentary on the Old Testament, he pitched the claims of the sacred theory on a much lower key. He says: "Mankind was of one language, in all likelihood the Hebrew. . . . The proper names and other significations given in the Scripture seem incontestable evidence that the Hebrew language was the original language of the earth, the language in which God spoke to man, and in which he gave the revelation of his will to Moses and the prophets." Here are signs that this great champion is growing weaker in the faith; in the citations made it will be observed he no longer says "is," but "seems"; and finally we have him saying, "What the first language was is almost useless to inquire, as it is impossible to arrive at any satisfactory information on this point."

In France, during the first half of the nineteenth century, yet more heavy artillery was wheeled into place, in order to make a last desperate defense of the sacred theory. The leaders in this effort were the three great Ultramontanes, De Maistre, De Bonald, and Lammenais. Condillac's contention that "languages were gradually and insensibly acquired, and that every man had his share of the general result," they attacked with reasoning based upon premises laid down in the Book of Genesis. De Maistre especially excels in ridiculing the philosophic or scientific theory. Lammenais, who afterward became so vexatious a thorn in the side of the Church, insisted, at this earlier period, that "man can no more think without words than see without light." And then, by that sort of mystical play upon words so well known in the higher ranges of theologic reasoning, he clinches his argument by saying, "The Word is truly and in every sense 'the light which lighteth every man that cometh into the world.'"

But even such leaders as these could not stay the progress of thought. While they seemed to be carrying everything before them in France, researches in philology made at such centers of thought as the Sorbonne and the College of France were undert mining the last great fortress. Curious indeed is it to find tha- the Sorbonne, the stronghold of theology through so many centuries, was now made in the nineteenth century the arsenal and stronghold of the new ideas. But the most striking result of the new tendency in France was seen when the greatest of the three champions, Lammenais himself, though offered the highest church preferment, and even a cardinal's hat, braved the papal anathema, and went over to the scientific side.*

In Germany philological science took so strong a hold that its positions were soon recognized as impregnable. Leaders like the Schlegels, William von Humboldt, and, above all, Franz Bopp and Jacob Grimm, gave such additional force to scientific truth that it could no longer be withstood. To say nothing of other conquests, the demonstration of that great law in philology which bears Grimm's name brought home to all thinking men the evi-

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* For Johnson's work, showing how Moses learned the alphabet, see the Collection of Discourses by Rev. John Johnson, A. M., Vicar of Kent, London, 1728, p. 42, and the preface. For Beattie, see his Theory of Language, London, 1788, p. 98; also pp. 100, 101. For Adam Clarke, see, for the speech cited, his Miscellaneous Works, London, 1837; for the passage from his Commentary, see the London edition of 1836, vol. i, p. 93; for the other passage, see Introduction to Bibliographical Miscellany, quoted in article, Origin of Language and Alphabetical Characters, in Methodist Magazine, vol. xv, p. 214. For De Bonald, see his Recherches Philosophiques, Part III, chap. ii, De l'Origine du Langage, in Œuvres Complètes, Paris, 1859, pp. 64–78, *passim*. For Joseph De Maistre, see his Œuvres, Bruxelles, 1852, vol. i, Les Soirées de Saint Petersbourg, deuxième entretien, *passim*. For Lammenais, see his Œuvres Complètes, Paris, 1836–'37, tome ii, 78–81, chap. xv of Essai sur l'Indifférence en Matière de Religion.

dence that the evolution of language has not been determined by the philosophic utterances of Adam in naming the animals which Jehovah brought before him, but in obedience to natural law.

True, a few devoted theologians showed themselves willing to lead a forlorn hope; and perhaps the most forlorn of all was that of 1840, led by Dr. Gottlieb Christian Kayser, Professor of Theology at the Protestant University of Erlangen. He did not, indeed, dare put in the old claim that Hebrew is identical with the primitive tongue, but he insists that it is nearer it than any other. He relinquishes the two former theological strongholds—first, the idea that language was taught by the Almighty to Adam, and, next, that the alphabet was thus taught to Moses—and falls back on the position that all tongues are thus derived from Noah, giving as an example the language of the Caribbees, and insisting that it was evidently so derived. What chance similarity in words between Hebrew and the Caribbee tongue he had in mind is past finding out. He comes out strongly in defense of the biblical account of the Tower of Babel, and insists that by the "symbolical expression 'God said, Let us go down,' a further natural phenomenon is intimated, to wit, the cleaving of the earth, whereby the return of the dispersed became impossible—that is to say, through a new or not universal flood, a partial inundation and temporary violent separation of great continents until the time of the rediscovery." By these words the learned doctor means nothing less than the separation of Europe from America.

But while at the middle of the nineteenth century the theory of the origin and development of language was upon the continent considered as settled, and a well-ordered science had there emerged from the old chaos, Great Britain still held back, in spite of the fact that the most important contributors to the science were of British origin. Leaders in every English church and sect vied with each other, either in denouncing the encroachments of the science of language or in explaining it away.

But a new epoch had come, and in a way least expected. Perhaps the most notable effort in bringing it in was made by Dr. Wiseman, afterward Cardinal Archbishop of Westminster. His is one of the best examples of a method which has been used with considerable effect during the latest stages in nearly all the controversies between theology and science. It consists in stating, with much apparent fairness, the conclusions of the scientific authorities, and then in making the astounding assertion that the Church has always accepted them and accepts them now as "additional proofs of the truth of Scripture" A little juggling with words, a little amalgamation of texts, a little judicious suppression, a little imaginative deduction, a little unctuous phrasing, and the thing is done. One great service this eminent Catholic champion undoubtedly rendered: by this acknowledgment so widely spread in his published lectures, he made it impossible for Catholics or Protestants longer to resist the main conclusions of science. Henceforward we only have efforts to save theological appearances, and these only by men whose zeal outran their discretion.

On both sides of the Atlantic, down to a recent period, we see these efforts, but we see no less clearly that they are mutually destructive. Yet out of this chaos among English-speaking peoples the new science began to develop steadily and rapidly. Attempts did indeed continue here and there to save the old theory. Even as late as 1859 we hear the eminent Presbyterian divine, Dr. John Cumming, from his pulpit in London, speaking of Hebrew as "that magnificent tongue—that mother-tongue, from which all others are but distant and debilitated progenies."

But the honor of producing in the nineteenth century the most absurd known attempt to prove Hebrew the primitive tongue belongs to the youngest of the continents, Australia. In the year 1857 was printed at Melbourne The Triumph of Truth, or a Popular Lecture on the Origin of Languages, by B. Atkinson, M. R. C. P. L.—whatever that may mean. In this work, starting with the assertion that "the Hebrew was the primary stock whence all languages were derived," the author states that Sanskrit is "a dialect of the Hebrew," and declares that "the manuscripts found with mummies agree precisely with the Chinese version of the Psalms of David." It all sounds like Alice in Wonderland. Curiously enough, in the latter part of his book, evidently thinking that his views would not give him authority among fastidious philologists, he says, "A great deal of our consent to the foregoing statements arises in our belief in the divine inspiration of the Mosaic account of the creation of the world and of our first parents in the garden of Eden." A yet more interesting light is thrown upon the author's view of truth and its promulgation by his dedication; he says that, "being persuaded that literary men ought to be fostered by the hand of power," he dedicates his treatise "to his Excellency Sir H. Barkly," who was at the time Governor of Victoria.

Still another curious survival is seen in a work which appeared as late as 1885, at Edinburgh, by William Galloway, M. A., Ph. D., M. D. The author thinks that he has produced abundant evidence to prove that "Jehovah, the Second Person of the Godhead, wrote the first chapter of Genesis on a stone pillar; and that this is the manner by which he first revealed it to Adam; and thus Adam was taught not only to speak but to read and write by Jehovah, the Divine Son; and that the first lesson he got was from the first chapter of Genesis." He goes on to say:

"Jehovah wrote these first two documents; the first containing the history of the Creation, and the second the revelation of man's redemption, . . . for Adam's and Eve's instruction; and it is evident that he wrote them in the Hebrew tongue, because that was the language of Adam and Eve." But this was only a flower out of season.

And finally in these latter days Mr. Gladstone has touched the subject. With that well-known facility in believing anything he wishes to believe, which he once showed in his connection of Neptune's trident with the doctrine of the Trinity, he floats airily over all the impossibilities of the original Babel legend and all the conquests of science, makes an assertion regarding the results of philology which no philologist of any standing would admit, and then escapes in a cloud of rhetoric after his well-known fashion. This, too, must be set down simply as a survival; in the British Isles as elsewhere the truth has been established. Such men as Max Müller and Sayce in England; Steinthal, Schleicher, Weber, Karl Abel, and a host of others in Germany; Ascoli and De Gubernatis in Italy; and Whitney, with the scholars inspired by him, in America, have carried the new science to a complete triumph. The sons of Yale University may well be proud of the fact that this old Puritan foundation was made the headquarters of the American Oriental Society, which has done so much for the truth in this field.*

It may be instructive, in conclusion, to sum up briefly the history of the whole struggle.

First, as to the origin of speech, we have in the beginning the whole Church rallying around the idea that the original language was Hebrew; that this language, even including the mediæval rabbinical punctuation, was directly inspired by the Almighty; that Adam was taught it by God himself in walks and talks; and that all other languages were derived from it at the "confusion of Babel."

Next, we see parts of this theory fading out: the inspiration of the rabbinical points begins to disappear; Adam, instead of being taught directly by God, is "inspired" by him.

Then comes the third stage: advanced theologians endeavor to compromise on the idea that Adam was "given verbal roots and a mental power."

Finally, in our time, we have them accepting the theory that language is the result of an evolutionary process in obedience to

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* For Mr. Gladstone's view, see his Impregnable Rock of Holy Scripture, London, 1890, p. 241 *et seq.* The passage connecting the trident of Neptune with the Trinity is in his Juventus Mundi. To any American boy who sees how inevitably, both among Indian and white fishermen, the fish-spear takes this three-pronged form, this utterance of Mr. Gladstone is amazing.

laws more or less clearly ascertained. Babel thus takes its place quietly among the sacred myths.

Secondly, as to the origin of writing, we have the more eminent theologians at first insisting that God taught Adam to write; next we find them gradually retreating from this position, but insisting that writing was taught to the world by Noah. After the retreat from this position, we find them insisting that it was Moses whom God taught to write. But scientific modes of thought still progressed, and we next have influential theologians agreeing that writing was a Mosaic invention; this is followed by another theological retreat to the position that writing was a post-Mosaic invention. Finally, all the positions are relinquished, save by some few skirmishers who appear now and then upon the horizon, making attempts to defend some subtle method of incorporating the Babel myth into modern science.

Just after the middle of the nineteenth century a new system of theological defense appears. It is that which is seen in the history of almost every science after it has successfully fought its way through the theological period—the declaration that the scientific discoveries in question are nothing new, but have really always been known and held by the Church, and that they simply substantiate the position taken by the Church. This new contention, which always betokens the last gasp of theological resistance to science, was now echoed from land to land. In 1856 it was given forth by a divine of the Anglican Church, Archdeacon Pratt, of Calcutta. He gives a long list of eminent philologists who had done most to destroy the old supernatural view of language, reads into their utterances his own wishes, and then exclaims, "So singularly do their labors confirm the literal truth of Scripture."

Two years later this contention is echoed from the American Presbyterian Church, and Dr. B. W. Dwight, having stigmatized as "infidels" those who have not incorporated into their science the literal acceptance of Hebrew legend, declares that "chronology, ethnography, and etymology have all been tortured in vain to make them contradict the Mosaic account of the early history of man." Twelve years later another echo comes from the Roman Catholic Church. The Rev. Dr. Baylee, Principal of the College of St. Aidan's in England, declares, "With regard to the varieties of human language, the account of the confusion of tongues is receiving daily confirmation by all the recent discoveries in comparative philology." And this is echoed in the same year (1870) from the United Presbyterian Church of Scotland, when Dr. John Eadie, Professor of Biblical Literature and Exegesis, declares that "comparative philology has established the miracle of Babel."

A skill in theology and casuistry so exquisitely developed as to permit such assertions, and a faith so robust as to warrant their acceptance, leave certainly nothing to be desired. But how baseless these contentions are is seen, first, by the simple history of the attitude of the Church toward this question; and, secondly, by the fact that comparative philology now reveals beyond a doubt that not only is Hebrew not the original or oldest language upon earth, but that it is not even the oldest form in the Semitic group to which it belongs. To use the language of one of the most eminent modern authorities, "It is now generally recognized that in grammatical structure the Arabic preserves much more of the original forms than either the Hebrew or Aramaic."

Science places inexorably the account of the confusion of tongues and the dispersion of races at Babel among the myths.

A more complete relinquishment of the old contention is made by Archdeacon Farrar, Canon of Westminster. With a boldness which in an earlier period might have cost him dear, but which merits praise even in this time for its courage, he says: "For all reasoners except that portion of the clergy who in all ages have been found among the bitterest enemies of scientific discovery, these considerations have been conclusive. But, strange to say, here, as in so many other instances, this self-styled orthodoxy—more orthodox than the Bible itself—directly contradicts the very Scriptures which it professes to explain, and by sheer misrepresentation succeeds in producing a needless and deplorable collision between the statements of Scripture and those other mighty and certain truths which have been revealed to science and humanity as their glory and reward."

Still another most honorable acknowledgment was made in America through the instrumentality of a divine of the Methodist Episcopal Church, whom the present generation at least will hold in honor, not only for his scholarship, but for his patriotism in the darkest hour of his country's need—John McClintock. In the article on Language, in the Biblical Cyclopædia, edited by him and the Rev. Dr. Strong, which appeared in 1873, the whole sacred theory is quietly given up, and the scientific view accepted.*

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* For Kayser, see his work, Ueber die Ursprache, oder über eine Behauptung Mosis, dass alle Sprachen der Welt von einer einzigen der Noachischen abstammen, Erlangen, 1840, 192 pp.; see especially pp. 5, 80, 95, 112. For Wiseman, see his Lectures on the Connection between Science and Revealed Religion, London, 1836. For examples typical of very many in this field, see the Works of Pratt, 1856; Dwight, 1858; Jamieson, 1868. For citation from Cumming, see his Great Tribulation, London, 1859, p. 4; see also his Things hard to be understood, London, 1861, p. 48. For an admirable summary of the work of the great modern philologists, and a most careful estimate of the conclusions reached, see Prof. Whitney's article on Philology in the Encyclopædia Britannica. A copy of Mr. Atkinson's book is in the Harvard College Library, it having been presented by the

It may, indeed, be now fairly said that the thinking leaders of theology have come to accept the conclusions of science regarding the origin of language, as against the old explanations by myth and legend. The result has been a blessing both to science and to religion. No harm has been done to religion; what has been done is to release it from the clog of theories, which thinking men saw could no longer be maintained. No matter what has become of the naming of the animals by Adam, the origin of the name of Babel, the fears of the Almighty lest men might climb up into his realm above the firmament, the confusion of tongues and the dispersion of nations; the essentials of Christianity, as taught by its Blessed Founder, have simply been freed, by comparative philology, from one more great incubus and incumbrance, and have therefore been left to work with more power upon the hearts, minds, and conduct of mankind.

Nor has any harm been done to the Bible. On the contrary, it has been made, by this new divine revelation through science, all the more precious to us. In these myths and legends caught from earlier civilizations, we see an evolution of the most important religious and moral truths for our race. Myth, legend, and parable seem, in obedience to a divine law, the necessary setting for these truths, as they are successively evolved, ever in higher and higher forms. What matters it then that we have come to know that the accounts of Creation and many early events in the sacred books were remembrances of lore obtained from the Chaldeans? What matters it that the beautiful story of Joseph is found to be in part derived from an Egyptian romance, of which the hieroglyphs may still be seen? What matters it that the story of David and Goliath is poetry; and that Samson, like so many men of strength in other religions, is probably a sun-myth? What matters it that the inculcation of high duty in the childhood of the world is embodied in such quaint stories as those of Jonah and Balaam? The more we realize these facts the richer becomes that great body of literature

Trustees of the Public Library of Victoria. For Galloway, see his Philosophy of the Creation, Edinburgh and London, 1885, pp. 21, 238, 239, 446. For citation from Baylee, see his Verbal Inspiration the True Characteristic of God's Holy Word, London, 1870, p. 14, and elsewhere. For Archdeacon Pratt, see his Scripture and Science not at Variance, London, 1856, p. 55. For the citation from Dr. Eadie, see his Biblical Cyclopædia, London, 1870, p. 53. For Dr. Dwight, see The New-Englander, vol. xvi, p. 465. For the theological article referred to as giving up the sacred theory, see the Cyclopædia of Biblical, Theological, and Ecclesiastical Literature, prepared by Rev. John McClintock, D. D., and James Strong, New York, 1873, vol. v, p. 233. For Arabic as an earlier Semitic development than Hebrew, as well as for much other valuable information on the questions recently raised, see article Hebrew, by W. R. Smith, in the latest edition of the Encyclopædia Britannica. For quotation from Canon Farrar, see his Language and Languages, London, 1878, pp. 6, 7.

brought together within the covers of the Bible. What matters it that those who incorporated the Creation lore of Babylonia and other Oriental nations into the sacred books of the Hebrews, mixed it with their own conceptions and deductions? What matters it that Darwin changed the whole aspect of our Creation myths; that Lyell and his compeers placed the Hebrew story of Creation and of the Deluge of Noah among legends; that Copernicus put an end to the literal acceptance of the standing still of the sun for Joshua; that Halley, in promulgating his law of comets, put an end to the doctrine of signs and wonders; that Pinel, in showing that all insanity is physical disease, relegated to the realm of mythology the witch of Endor and all stories of demoniacal possession; that the Rev. Dr. Schaff, and a multitude of recent Christian travelers in Palestine, have put into the realm of legend the story of Lot's wife transformed into a pillar of salt; that the anthropologists, by showing how man has risen everywhere from low and brutal beginnings, have destroyed the whole theological theory of "the fall of man"? Our great body of sacred literature is thereby only made more and more valuable to us: more and more we see how long and patiently the forces in the universe which make for righteousness have been acting in and upon mankind through the only agencies fitted for such work in the earliest ages of the world—through myth, legend, parable, and poem.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

III. IRON-SMELTING BY MODERN METHODS.

By WILLIAM F. DURFEE, Engineer.

THUS far in these papers we have dealt only with iron smelted by charcoal, and, in fact, up to the year 1830, there had been no attempt whatever to utilize either anthracite or bituminous coal for the purpose. In regard to the use of mineral coal Swank quotes as follows from a letter dated March 18, 1825, from the acting committee of the Pennsylvania Society for the Promotion of Internal Improvements to William Strikeland, who was its European agent: "No improvements have been made here in it [the manufacture of iron] within the last thirty years, and *the use of bituminous and anthracite coal in our furnaces is absolutely and entirely unknown.* Attempts, and of the most costly kind, have been made to use the coal of the western part of our State in the production of iron. Furnaces have been constructed according to the plan *said* to be adopted in Wales and elsewhere; persons claiming experience in the business have been employed; but all has been unsuccessful."

In the year 1835 the Franklin Institute offered a gold medal "to the person who shall manufacture in the United States the greatest quantity of iron from the ore during the year, using no other fuel than anthracite coal, the quantity to be not less than twenty tons." This medal was never awarded, and it is fair to presume that the required quantity of iron was not manufactured by any one person in 1835 by "using no other fuel than anthracite coal." Nevertheless, there is abundant evidence to prove that from the year 1830 to the year 1840 there were a number of attempts to use mineral fuel for the smelting of iron-ores.

The most successful of these experiments was tried at Pottsville, Pa., and the works were called the Pioneer Furnace. It was built for Burd Patterson, by William Lyman, of Boston, and blast was unsuccessfully applied July 10, 1839, but the furnace was finally successfully blown in by Benjamin Perry, October 19, 1839, and produced twenty-eight tons per week of good foundry iron. "This furnace," say Bishop, "made a continuous blast of ninety days, and secured for its proprietor a premium of $5,000 which had been subscribed by citizens of the State." On June 5, 1839, Mr. David Thomas, who had been associated with Mr. George Crane in making pig iron with anthracite coal at Yniscedwin, in Wales, arrived in America, and on July 9th of the same year he commenced the erection of the first furnace of the Lehigh Crane Iron Company at Catasauqua, Pa. This furnace was successfully blown in by him on the 3d of July, 1840, and the first "cast" was made on July 4th. The furnace was provided with a hot blast, and was blown by water power derived from the Lehigh Canal. This enterprise was a success from the start, the furnace producing fifty tons of good foundry iron per week, and it continued to be profitably operated until 1879, when it was torn down. Notwithstanding the fact that there were several promising experimental attempts to smelt iron with anthracite coal prior to the erection of a furnace at Catasauqua by Mr. Thomas, yet this furnace, from its large initial output (as measured by the practice of the time) and continuous operation, and the fact that it pointed out clearly the essential requisites of success in smelting with anthracite coal—viz., large capacity of furnace, supplied with abundance of blast at a high temperature*—may fairly be considered the first furnace in America that achieved a satisfactory commercial success in making iron with anthracite as a fuel. From his success in the erection and operation of this furnace, and subsequent life-long identification with the manufacture of anthracite pig iron, on a scale far surpassing any of his contemporaries, Mr. Thomas is fairly entitled to be called the father of the anthracite iron industry of

* The "hot blast" was invented by James Beaumont Neilson, of Glasgow, in 1828.

America. He died at Catasauqua on June 20, 1882, in his eighty-eighth year.

Fig. 31 is a view of the first furnace erected at Catasauqua by Mr. Thomas.* This furnace was about forty feet square at the base and forty feet high; it was twelve feet internal diameter at the "boshes," and was lined with nine-inch fire-brick brought from Risca, in Wales. The hearth was four feet square. At first the "hot-blast stoves" were on the ground and fired with coal; they were three in number, and each contained two "bed pipes," connected by ten semicircular "siphon pipes." Each "stove" had a fire-grate at one end, and at the other was a chimney provided

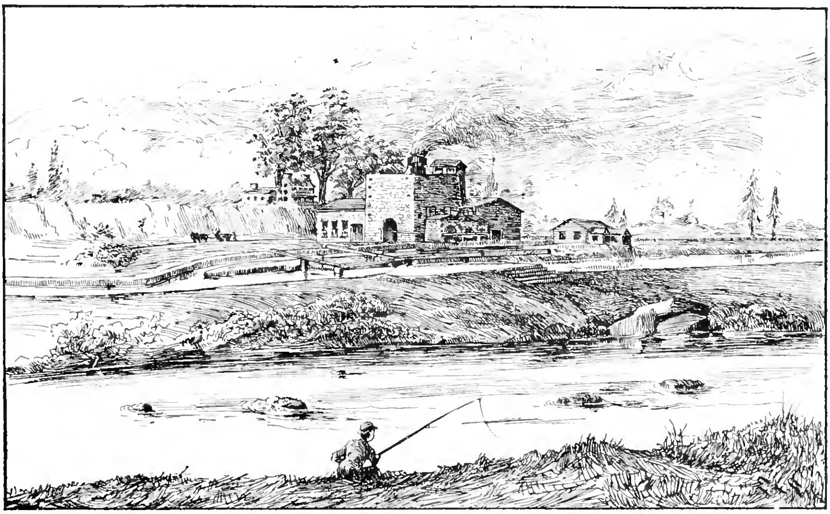

Fig. 31.—Early Anthracite Iron-Furnace at Catasauqua.

with a damper at its top. The gas escaped freely at the "tunnel-head," and was, of course, wasted. The first blowing machinery comprised a "breast" water-wheel, twenty-five feet long and twelve feet in diameter; this operated two blowing cylinders five feet in diameter and six feet stroke. At first the pressure of blast was only about a pound and a half, but the following year another water-wheel of the same size was added, after which the pressure of blast was increased to two pounds and a half per square inch. The head and fall of the water-supply was eight

* Diligent inquiry failed to discover any photograph or engraving of this furnace; but from some plans and elevations, combined with explanatory information kindly furnished by John Thomas, Esq., Superintendent of the Thomas Iron Works, Hokendauqua, Pa., together with information obtained from Oliver Williams, Esq., President of Catasauqua Manufacturing Company, during a visit to the site of the old furnace, a pen-and-ink drawing was made by the writer, from which the above engraving was reduced. It is said to give a very correct idea of the furnace and its surroundings.

feet, the "head-race" taking its water from above the lock opposite the furnace, and the "tail-race" discharging into the lower level of the canal, below the lock. With one water-wheel the "make" of iron was only about twenty-five to thirty tons per week, but with the second wheel the production was increased to upward of forty tons, varying, of course, with the condition of the water-supply, and sometimes reaching sixty to seventy tons. In years afterward this furnace, with still more powerful blowing machinery, made one hundred and seventy-two tons of iron in a week. The furnace was filled by a water hoist, consisting of two "tubs" about six feet square, suspended to a chain passing over a large pulley at the top of the hoist tower; the tops of these tubs

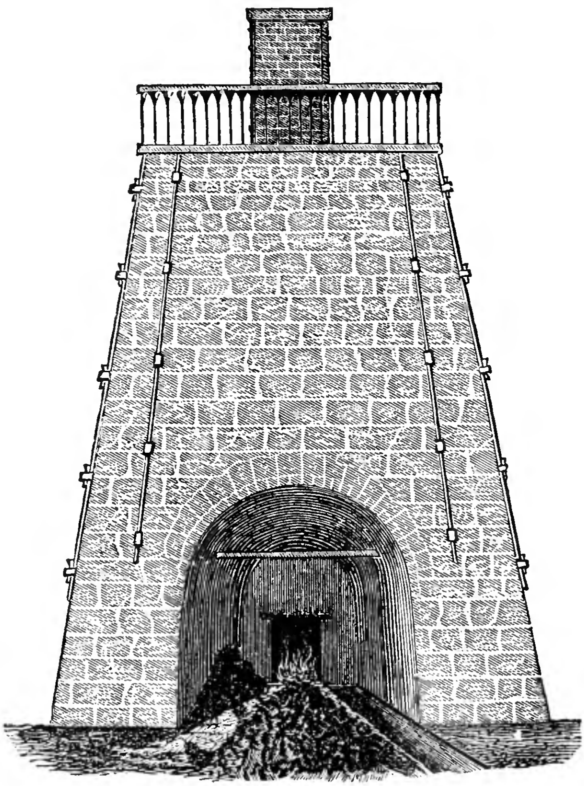

Fig. 32.—A Charcoal Blast-Furnace.

were covered and formed platforms on which the barrows were raised. By letting the water out of the tub that chanced to be at the bottom of the tower, the weight of water in the tub at the top caused it to descend, thus raising the other tub with its load. In order to operate this hoist, it was necessary to have a water-supply at the top of the furnace to fill the tub that was at the top.

At first nothing but the coal was dumped into the furnace, the ore and limestone being charged with iron pans similar to the baskets formerly used at charcoal furnaces; the limestone was broken quite small.

After the success of this furnace was assured, furnaces in which mineral fuel (either anthracite or coke, or a mixture of the two, with an occasional use of raw bituminous coal) was exclusively used rapidly increased. Various changes and improvements naturally took place as time passed and experience was gained; but year by year the volume of iron smelted by mineral fuel increased relative to that made by charcoal, until in 1889 it reached the grand total of 7,871,779 tons, while "the make" of the charcoal furnaces amounted to but 644,300 tons.*

Notwithstanding the practical demonstration by David Thomas that mineral coal could be successfully used for smelting iron, charcoal furnaces continued to be built. The general appearance of such furnaces as were erected during the fifteen years following the year 1840 is well represented in Fig. 32, of which Fig. 33 is a vertical section. As a rule they were no better in idea, and but little in execution, than those described by Swedenborg a century before; but, after the year 1855, the construction of furnaces began to receive more careful attention, and by the year 1860 the best-informed metallurgical engineers (whose profession was just beginning to be recognized) had discovered that uncouth bulk and crude workmanship were not desirable features in a furnace for the making of pig iron. Yet, nevertheless, some of the stragglers who are always found hovering in the rear of the grand army of progress, and who never know what is going on at the

* Nevertheless, the actual total production of charcoal iron is found to be increasing, as there were but 348,954 tons made in 1856, little more than half the product of 1889. The modern charcoal furnace produces much more iron per year than those constructed thirty-four years ago. The total output of charcoal iron for 1889 was made in 63 furnaces, which would require an average annual production of 10,227 tons per furnace; while in 1856 the total output of charcoal iron came from 416 furnaces, which therefore produced an annual average of but 838 tons per furnace. This calculation is based upon the supposition that all the furnaces reported in 1856 were in operation. Of this there is a little uncertainty; but, after making the most liberal allowance for this, it is still evident that the average annual output of the modern charcoal furnace is many times greater than that of the furnace as constructed in 1856.

A similar calculation applied to the production of anthracite iron (including that made with a mixture of anthracite and coke) shows that in 1889 each furnace produced 18,465 tons of iron, while in 1856 each furnace made but 3,268 tons, or, in other words, the furnace of to-day produces $5\frac{6}{10}$ times as much as that erected thirty-four years ago.

By a comparison of the old bituminous and coke furnaces with those of our time using the same fuels, we learn that in 1856 the average annual output of this class of furnace was 1,617 tons, and that in 1889 the average make of the bituminous and coke furnaces was 34,188 tons. From these figures it appears that the furnaces of 1889 were twenty-one times more productive than those of 1856.

front, built furnaces, as late as 1864, that, when measured by the standard of the available knowledge of the time, were little better than ponderous aggregations of ignorance and masonry.

Among the earlier of the many improvements in the details of blast-furnace construction and management, which were made in consequence of the employment of mineral coal for smelting, was

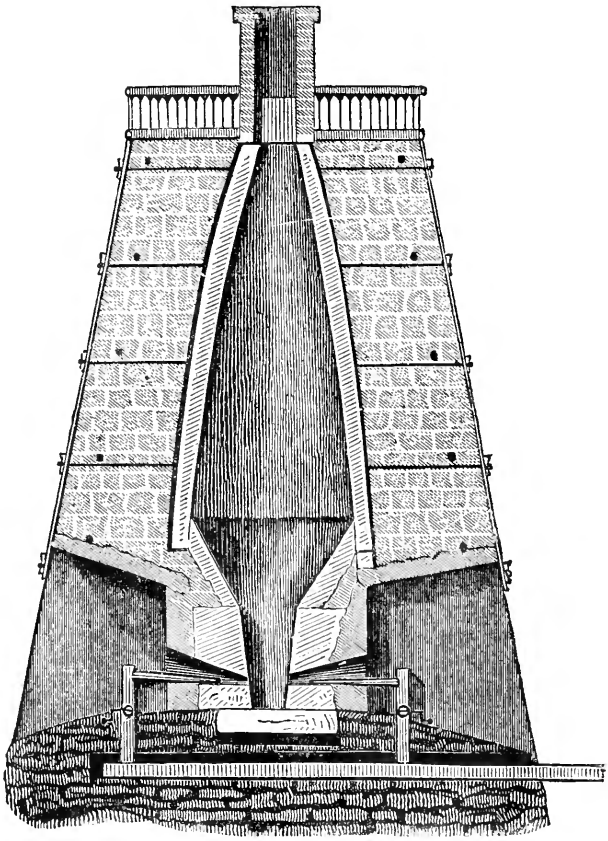

Fig. 33.—Vertical Section of a Charcoal Blast-Furnace.

the substitution of blowing cylinders of iron for the wooden blowing apparatus previously employed in connection with charcoal furnaces. One of the simplest forms of iron blowing machinery is shown in Fig. 34. This apparatus consisted of two vertical "blowing cylinders," provided with appropriate valves, through which the air was drawn in and discharged into a "wind-chest" by the vertical reciprocation of a piston in each cylinder. These pistons were actuated by the cranks on the gear-wheel shown, through the intervention of suitable connecting-rods and walking-beams. The cut (Fig. 34) conveys only the simplest form of the idea embodied in the walking-beam blowing-engine, and is very far from adequately representing the latest exemplification of that idea, as carried out in the colossal machines employed to blow many of the largest modern furnaces.

There is great variety in the construction of blast-heating apparatus, but it can be comprehensively described as consisting of

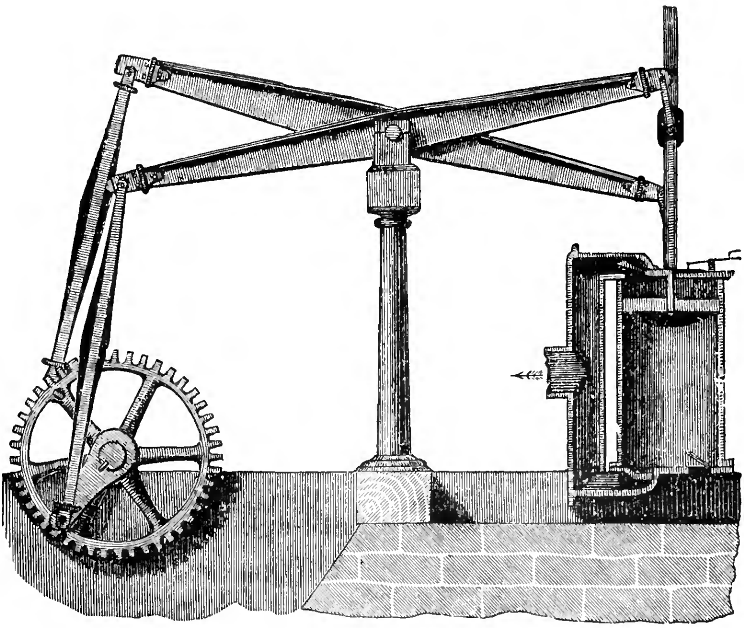

FIG. 34.—IRON BLOWING-ENGINE.

two well-defined types: (1) those forms in which the air is heated by passing through hot iron pipes, inclosed in a brick chamber or "oven"; (2) those forms in which the blast is heated by actual contact with red-hot masses of brick-work inclosed in air-tight chambers. Fig. 35 is a vertical longitudinal section, and Fig. 36 a vertical transverse section, of one of the best of the many forms of the first-named type of "hot-blast stove." This construction of "stove" was the invention of John Player, of England, who introduced it to the notice of American iron-masters in 1867; and the first "Player stove" in the United States was erected at the anthracite furnace of J. B. Moorehead & Co., at West Conshohocken, Pa. Before Mr. Player came to America it had been the usual though not universal practice to place the gas-fired "hot-blast stoves," as well as steam-boilers, on the same level as the top of the furnace, but in all the furnaces erected by him he placed the "hot-blast stoves" and the boilers on the ground, and brought the gas down to them in a large pipe or "down-comer" as it was called.

The "Player stove" was provided at its base with a large "combustion chamber" (see Fig. 35), into which the gas entered, and there meeting with sufficient air for its combustion, the resulting heated gases passed upward through flues (indicated by the arrows *s*, *s*, *s*) in the roof of the "combustion chamber" into the "pipe chamber" above. In this chamber were arranged a series of vertical "siphon pipes," standing upon hollow bases or

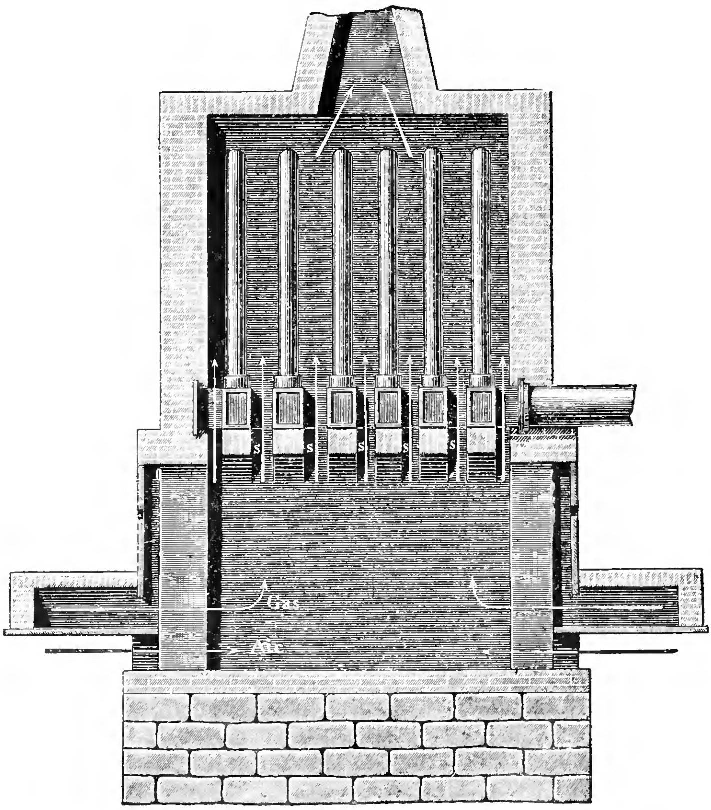

Fig. 35.—Longitudinal Section of the Player Hot-blast Stove.

"bed pipes" of cast iron. The air to be heated was admitted to the right-hand bed pipe B (Fig. 36), and passed thence in the direction of the arrows through the siphon pipes into the left-hand bed pipe B′, from one end of which it was taken in suitable pipes to the furnace. The introduction of the "Player stove" was the means of greatly increasing the production of iron in the furnaces to which they were applied, and at the same time the amount of fuel required per ton of iron was diminished; further economies were realized by increasing the size of furnaces, and the power of the engines that supplied them with blast.

The first example of the second type of hot-blast stove erected in America was put in operation June 18, 1875, at Rising Fawn Furnace, in Dade County, Ga. The particular construction there used was that invented in England by Thomas Whitwell. Its general idea involved a cylindrical air-tight chamber of boiler iron lined with fire-brick; this chamber was traversed by a number of vertical parallel walls or diaphragms, also of fire-brick. The operation of this stove was as follows, viz.: The whole interior was heated to a very high temperature by means of the waste gas of the furnace which passed through the stove in the spaces between the fire-brick diaphragms. As soon as the stove was sufficiently heated the gas was turned off, and the blast was forced through the stove; and, as it traversed the spaces between the fire-brick walls on its way to the furnace, it absorbed heat from them and consequently reduced their temperature. This alternate heating and cooling of the stove, by the passage for a certain time, first of ignited gas, and then by the air to be heated, could be so regulated by suitable valves that a temperature of blast could be attained much higher than was possible in an iron-pipe stove. In order to insure regularity of working and uniformity of heat, it is usual to have at least three (some furnaces have four, and in Europe five have been used) such stoves to each furnace.

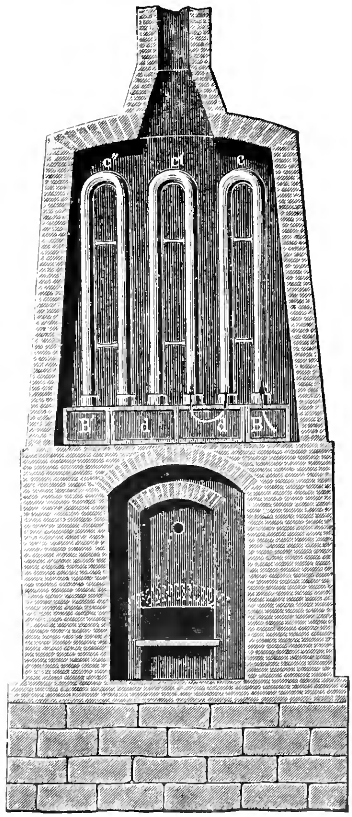

Fig. 36.—Transverse Section of the Player Stove.

Besides the Whitwell stove, there are at present a number of others of the second type in use, whose details differ somewhat, but they all have an air-tight chamber lined with fire-brick, as a common constructive feature; this chamber is filled with partitions, blocks, tubes, and perforated or loose brick, in a great variety of ways, for each of which is claimed peculiar merit by its inventor; but it is quite evident that the design of some of these stoves was inspired by the desire to avoid the consequences of infringing existing patents on tweedle-dum by constructing tweedle-dee.

A good idea of the internal arrangement of a Siemens-Cowper-Cochrane Stove* is conveyed by Fig. 37, in which the burning gases intensely heat the reticulated mass of fire-bricks B B, which in turn heat the air of the blast. All the fire-brick stoves are of such huge proportions that a modern furnace plant suggests a hot-blast apparatus with an attached furnace, rather than a furnace with hot-blast stoves.

Raw bituminous coal has been used to some considerable extent as a blast-furnace fuel since 1845, near the end of which year Mr. David Himrod (late of Youngstown, Ohio) used raw coal for a time with success in a furnace on Anderson's Run, Mercer County, Pa. This furnace had been "blown in" with charcoal, but the available quantity of this fuel being insufficient, some coke was mixed with it, and later raw coal was substituted for the coke; and we are told that "the furnace worked well and produced a fair quality of metal." The first furnace in America built with the intention of using raw bituminous coal as fuel was built in 1845 for Messrs. Wilkinson, Wilkes & Co., at Lowell, Mahoning County, Ohio. This furnace was successfully blown in with raw coal on the 8th of August, 1846, by John Crowther, an Englishman, who came to the United States in 1844, previous to which he had been the manager of seven furnaces in Staffordshire. Mr. Crowther adapted many furnaces in Ohio to the use of bituminous coal, and instructed his three sons, Joshua, Joseph J., and Benjamin, in their management. He died April 15, 1861, in England. The successful blowing in of the furnace at Lowell may be fairly

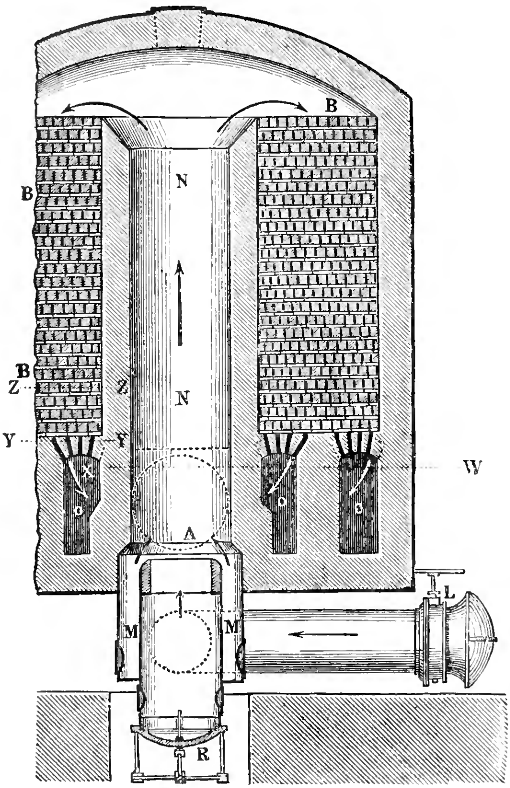

Fig. 37.—The Siemens-Cowper-Cochrane Hot-blast Stove.

* Invented by Dr. C. W. Siemens, Edward W. Cowper, and Charles Cochrane.

regarded as the commencement of the use of raw bituminous coal as a blast-furnace fuel in the United States.

Coke is the fuel by which over one half of the pig iron made in America at the present time is smelted.* The first public mention of coke as a possible substitute for charcoal in American blast-furnaces is contained in an advertisement which appeared in the Pittsburg Mercury of May 27, 1813. This is quoted by Weeks,† as follows, viz.:

"*To Proprietors of Blast-furnaces:*

"John Beal, lately from England, being informed that all the blast-furnaces are in the habit of melting iron-ore with charcoal, and knowing the great disadvantage it is to proprietors, is induced to offer his services to instruct them in the method of converting stone coal into *coak*. The advantage of using coak will be so great that it can not fail to become general if put to practice. He flatters himself that he has had all the experience that is necessary in the above branch to give satisfaction to those who feel inclined to alter their mode of melting their ore.

"JOHN BEAL, *Iron Founder.*

"N. B.—A line directed to the subscriber, post-paid, will be duly attended to."

There is no evidence that Mr. Beal was ever called upon to "instruct" the Pittsburg iron-masters of seventy-seven years ago in the art and mystery of making "*coak*," but doubtless his advertisement may have stimulated inquiring minds; for, four years after its appearance, we find that Colonel Isaac Meason used coke in the "refinery" of his mill at Plumsock, Fayette County, Pa. This mill went into operation in September, 1817, and it was the first mill west of the Alleghany Mountains in which iron was puddled and rolled into bars. Weeks, speaking of the use of coke in this mill, says, "This is the first definite statement that I have been able to find of the use of coke in this country." A short time after this first use of coke in America there were several attempts to employ it in a blast-furnace, but there is no record of any success in this direction until the building of the Lonaconing furnace, Alleghany County, Md., in 1837. This fur-

* This fact is a good illustration of the realization of great value from a material that was at first regarded with disfavor. Overman, writing in 1849 (The Manufacture of Iron, p. 179), says: "As we have previously remarked, there is but little prospect of seeing coke furnaces in successful operation in the United States. Nearly every State in the Union has good raw coal in sufficient quantity, as well as of proper quality, to supply its furnaces."

† Report on the Manufacture of Coke. By Joseph D. Weeks, Special Agent. New York: David Williams, 1885.

nace was (according to Overman *), "the first coke furnace whose operation was successful erected in this country. It is fifty feet high, fifty feet at the base, twenty-five feet at the top, and measures fifteen feet at the boshes." † In 1840 two large blast-furnaces were built by the Mount Savage Iron Company, at Mount Savage, Md. These furnaces also used coke, of which there was made, "from 1840 to 1850, between 50,000 and 75,000 tons"—"most of which was used at the furnaces." ‡ All the coke for the above furnaces was made in pits.

The manufacture of "Connellsville coke," which is regarded as especially excellent for smelting iron, was commenced in 1841. Weeks (writing in 1883) gives the following account of the beginning of the coke business in the Connellsville region: "Two carpenters, Provance McCormick and James Campbell, overheard an Englishman, so the story runs, commenting on the rich deposits of coal at Connellsville, and their fitness for making coke, as well as the value of coke for foundry purposes, and they determined to enter upon its manufacture. Mr. McCormick, who is still living, an old man of eighty-four, has given me an account from memory of this enterprise which I quote: 'James Campbell and myself heard, in some way that I do not now recollect, that the manufacturing of coke might be made a good business. Mr. John Taylor, a stone-mason, who owned a farm on which the Fayette Coke-works now stand, and who was mining coal in a small way, was spoken to regarding our enterprise, and proposed a partnership—he to build the ovens and make the coke, and Mr. Campbell and myself to build a boat and take the coke to Cincinnati, where we heard there was a good demand. This was in 1841. Mr. Taylor built two ovens. I think they were about ten feet in diameter. My recollection is that the charge was eighty bushels. The ovens were built in the same style as those now used, but had no iron ring at the top to prevent the brick from falling in when filling the oven with coal, nor had we any iron frames at the mouth where the coke was drawn. In the spring of 1842 enough coke had been made to fill two boats ninety feet long—about eight hundred bushels in each—and we took them to Cincinnati, down the Youghiogheny, Monongahela, and Ohio; but when we got there we could not sell. Mr. Campbell, who went with the boats, lay at the landing some two or three weeks, retailing one boat-load and part of the other in small lots at about eight cents a bushel. Miles Greenwood, a foundryman of that city, offered to

* The Manufacture of Iron in all its Various Branches, etc. By Frederick Overman, Mining Engineer. Philadelphia: Henry C. Baird, 1850.

† A good example of the phenomenally clumsy construction thought to be essential to successful working at that time.

‡ Weeks's Manufacture of Coke.

take the balance if we would take a small patent flour-mill at $125 in pay, which Mr. Campbell did. He shipped it here. We tried it, but it was no good, and we sold it to a man in the mountains for $30; and thus ended our coke business.' These gentlemen lost heavily in their venture. It was not until the Baltimore and Ohio Railroad was completed to Pittsburg, and Connellsville coke had been used successfully in the Clinton Furnace of Graff, Bennett & Co., at Pittsburg, that its value as a furnace fuel was thoroughly demonstrated and the foundation laid for the demand that has resulted in such a development of the coke manufacture in the Connellsville region. This furnace was blown in, in the fall of 1859. The coke was at first made from Pittsburg coal, near the furnace on the south side of the Monongahela River, nearly opposite the Point, at Pittsburg. The furnace was run for about three months, when, the coke made in this way not proving satisfactory, it was blown out, and arrangements made to secure a supply from the Connellsville region. The furnace blew in again early in the spring of 1860, the coke used being from the Fayette Coke-works on the Baltimore and Ohio Railroad, made at first on the ground in pits. The result was so satisfactory that thirty ovens were built in 1860, and arrangements were made to secure a continued supply."

The general tendency toward improvement in all branches of manufacturing that began to manifest itself in America about the year 1840, and which, fortunately for the welfare of the country, has grown with the years and strengthened with each new triumph of inventive thought, prompted investigation with a view to determine what constructive ideas were really essential to the building of a thoroughly efficient blast-furnace in which coke was to be used as the fuel; and it was very soon ascertained that European metallurgical engineers had discovered that it was not at all necessary to purchase a stone quarry before commencing the erection of a furnace, and that all the functions of successful smelting could be performed in a structure consisting substantially of a sheet-iron casing lined with fire-brick, supported upon cast-iron columns, between which were the *tuyères* and dam, which were thus rendered readily accessible; the furnace being entirely unincumbered with ponderous masses of supporting masonry. This form of furnace was not a creation, but the result of a gradual evolution from the old truncated pyramidal structure whose massive proportions were ignorantly supposed to be absolutely necessary, not only to support the weight of ore and fuel, but also to confine the heat in the furnace. The first deviation from the old construction consisted in a reduction of the quantity of material used by making all that part of the furnace above the *tuyère* arches either cylindrical or conical, and binding it with iron hoops; the lower portion remaining quite as massive as had been customary.

The next stage in the evolution made the whole furnace a frustum of a cone pierced at the base by four or more arches, that portion above the arches being hooped. The next change in construction consisted in casing the whole furnace, sustaining piers as well as the part above, in boiler iron. This construction was followed by the removal of the piers altogether, the upper conical portion of the furnace being built of cut stone hooped with iron and supported on cast-iron columns. Fig. 38 is an elevation and Fig. 39 a vertical section of one of the earlier furnaces of this construction. There were three such furnaces built at Hyanges, department of Moselle, France, prior to the year 1849 (probably in 1845). These furnaces were forty-six feet high and sixteen feet in diameter at the "boshes" and eight feet at the top. They were built expressly for the use of coke, and, according to Overman, they "worked admirably."

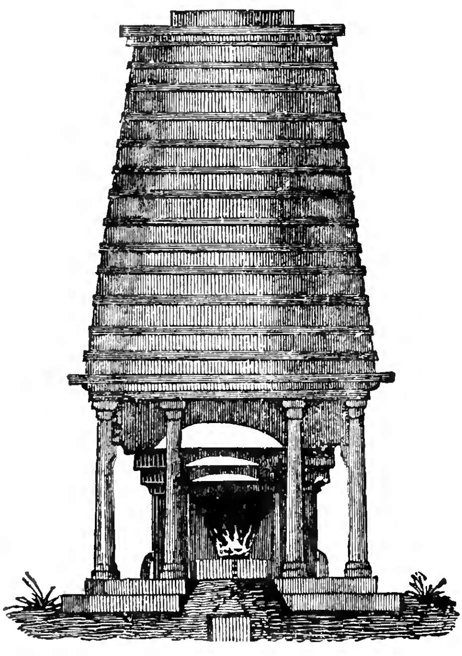

Fig. 38.—An Early French Coke Blast-Furnace.

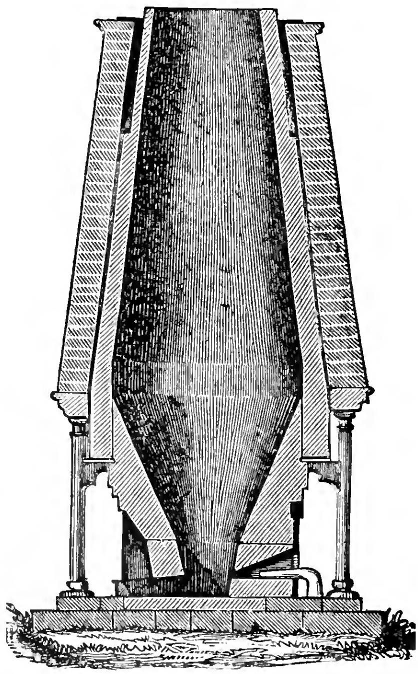

Fig. 39.—Section of French Coke Blast-Furnace.

The study of the construction and operation of such furnaces as these doubtless had its influence in determining the details of the Clinton Furnace of Graff, Bennett & Co., of Pittsburg, already referred to as having been the first to use "Connellsville coke" with success. This furnace, which I visited in January, 1863, was "simply a jacket" of boiler iron lined with fire-brick. It was fifty feet high and twelve feet "bosh."

The make of iron was twenty tons in twenty-four hours. Since the date of the erection of this furnace, which at the time was the only blast-furnace in Alleghany County (in which Pittsburg is situated), Pennsylvania, there have been built within its territory twenty-four coke furnaces, which produced in 1889 "more pig iron than the whole State of Ohio; more than twice as much as Illinois; and more than one seventh of the country's total production." *

The furnaces have not only increased in number, but their size and output have been very much augmented. As an illustration of this, furnace "F," of the "Edgar Thomson Steel Works," is eighty feet high, twenty-two feet diameter at the "boshes," eleven feet diameter of hearth, sixteen feet in diameter at the throat, and has a capacity of 18,000 cubic feet. This furnace produces 10,603 gross tons of iron per month (351 tons per day) on a fuel consumption of 1,756 pounds (coke) per gross ton. The pressure of blast at the *tuyères* is nine pounds per square inch, and its volume 25,000 cubic feet per minute, heated to 1,200° Fahrenheit.†

While the iron-masters west of the Alleghany Mountains were increasing the number, size, and economical working of their furnaces, the makers of "anthracite iron" in the Lehigh, Schuylkill, and Susquehanna Valleys were by no means idle; and their furnaces also increased in size and multiplied in number as the years passed. As illustrating the influence of a successful manufacture in drawing population and other industries to its immediate vicinity, no better instance could be selected than the town of Catasauqua, Pennsylvania, where was built in 1840 the furnace described in the first part of this article. Where then was but a single furnace, a small number of scattered houses, and a few score of people, we now find five furnaces, two rolling-mills, and a number of collateral industrial establishments, giving sustenance to a large and busy population. Fig. 40 is a view of the present blast-furnace plant at Catasauqua.‡ For the purpose of showing

* Annual Report of James M. Swank, Esq., General Manager of the American Iron and Steel Association, for the Year 1889.

† For these details I am indebted to the courtesy of James Gayley, Esq., Superintendent of Furnaces of the Edgar Thomson Steel Works.

‡ This view was taken looking diagonally up the Lehigh River; but in that of the old furnace (see Fig. 31) the spectator is supposed to be looking diagonally down the river, which in Fig. 40 is in front, and just without the limits of the picture. The Lehigh Canal, which is plainly seen in Fig. 31, is in Fig. 40 between the line of railway and the furnace buildings. The canal lock (shown in Fig. 31) is at the left of the picture, its lock-house being seen among the trees. The original furnace (1840) was located very near the large building, having a curved roof, on the end of which is the sign of the "Crane Iron Works." Nearly all the foreground, occupied by piles of pig iron, has been filled in since 1840.

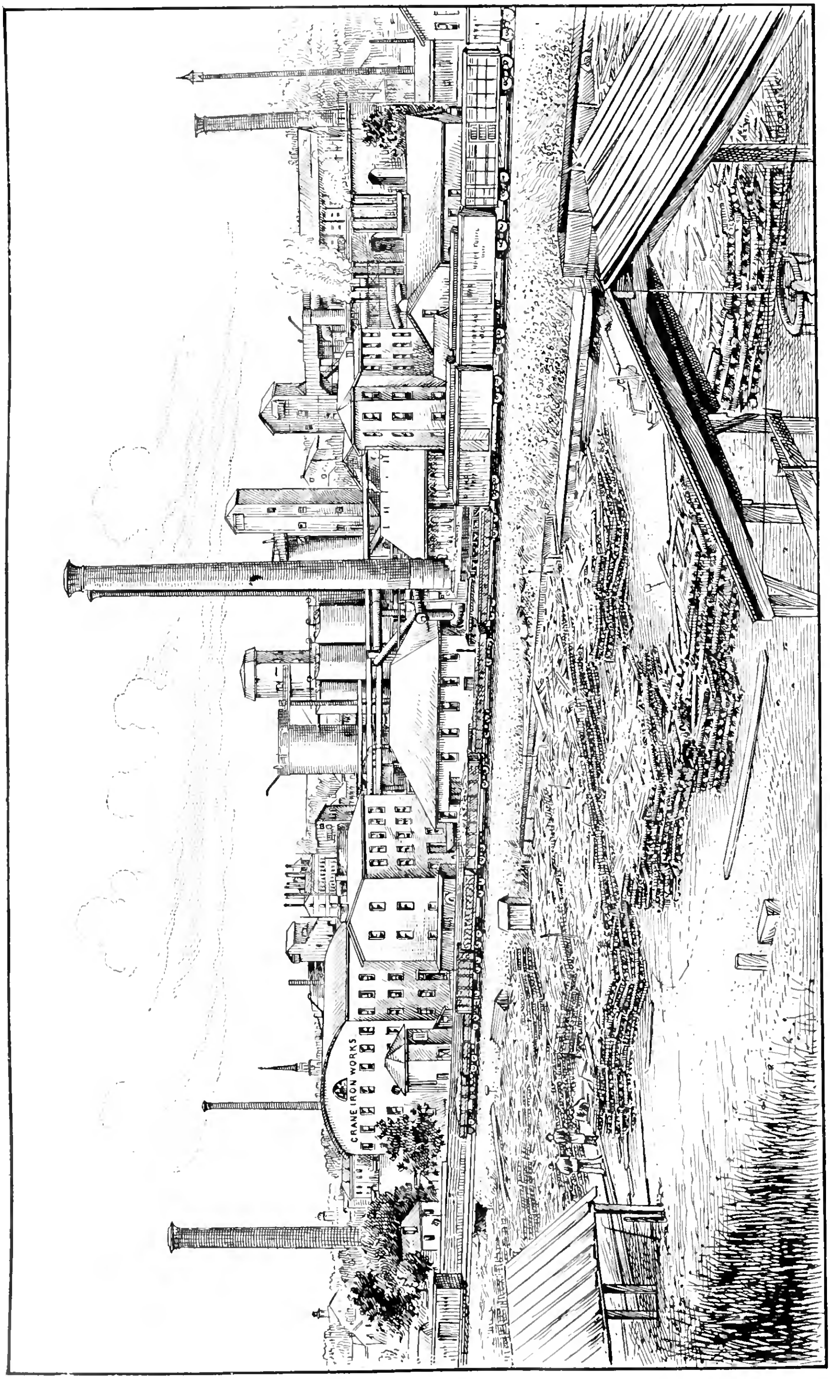

Fig. 40.—Iron Works at Catasauqua.

at what rate the technology of the manufacture of anthracite iron has advanced during these years, we will compare the product of the furnace of 1840 with that of the furnaces on the same ground at the present time. The original furnace made in the year ending July 1, 1841, 2,460 tons; and the present plant (five furnaces) produced during the year ending July 1, 1890, 111,828 tons, or at the rate of 22,365 tons per furnace (on the supposition that they were all running), which is more than nine times the product of the furnace built in 1840 at that place.

The production of pig iron in the United States for the year ending June 30, 1890, was the largest in the history of the country, and, in fact, larger than that of any other nation in the world, being 258,216 tons in excess of the production of Great Britain in 1889. The following table exhibits the rate of increase of production of pig iron during the past twenty years:*

DISTRICTS.	Tons of 2,000 pounds.		
	Year ending May 31, 1870.	Year ending May 31, 1880.	Year ending June 30, 1890.
New England States....	34,471	30,957	33,781
Middle States........................	1,311,649	2,401,093	5,216,591
Southern States........................	184,540	350,436	1,780,909
Western States........................	522,161	995,335	2,522,351
Far Western States........................	....	3,200	26,147
Totals........................	2,052,821	3,781,021	9,579,779

From the above figures we see that the manufacture of pig iron in New England has been practically stationary for the past twenty years, while in the Middle States it has nearly quadrupled, in the Western States it has increased nearly five times,† and in the Southern States nearly ten times in the same period.

Few persons save those connected with the manufacture of pig iron are aware of the enormous and insatiable appetite of one of the largest blast-furnaces; and the figures hitherto given fail to convey an adequate idea of the immense quantity of materials that pass through such a furnace, and it is only when the total daily amount of these materials is considered that the tremendous igneous activities constantly at work in that combination of hurricane and volcano—a modern blast-furnace of the first class—

* For this table and other facts relative to the output of pig iron in this country I am indebted to the report of Dr. William M. Sweet to Robert P. Porter, Superintendent of Census for 1890:

† A large proportion of this increase has been manufactured in Chicago and its immediate vicinity. This fact is confirmatory of a belief that the writer has entertained for many years, that Chicago was destined to be one of the important centers of the iron and steel manufacture of this country.

can be fully appreciated. Such a furnace will have passed through it in twenty-four hours the following materials:

Ore....	1,263,360	pounds or		564	gross tons.	
Coke	990,384	"	"	442	"	"
Limestone	353,741	"	"	158	"	"
Atmospheric air (blast)	2,331,840	"	"	1,041	"	"
Totals	4,939,325	"	"	2,205	"	"

which is equal to ninety-two tons per hour, or 1·53 tons per minute.* From this quantity of materials there will be produced in twenty-four hours 784,000 pounds or 350 gross tons of pig iron, which is at the rate of 32,666 pounds or 14·57 tons per hour, or 544 pounds per minute.

Heating the 25,000 cubic feet of air supplied per minute to a temperature of 1,200° Fahr., its volume would be increased to 85,000 cubic feet; and, on the supposition that the furnace is blown by seven *tuyères,* each seven inches in diameter, this torrid air would rush through each *tuyère* (under a pressure of nine pounds per square inch) at the rate of 12,143 cubic feet, and having the enormous lineal velocity of 45,417 feet per minute. This velocity is over five times that of the most violent tornadoes, and the pressure is more than twenty-five times greater. Should a blast of equal pressure and velocity come from unfathomed space and envelop this earth, it is absolutely certain that no living beings or loose materials would be left upon its rock-ribbed skeleton, which, stripped of its flesh and blood, fields and forests, lakes and oceans, would be hurled into a new orbit and made to assume revolutions and rotations whose amplitude and duration it is impossible to imagine or describe.

[*To be continued.*]

A CONTRIBUTION has been made to the speculations respecting the relative growth of the white and colored population of the United States by Quartermaster-General Meigs, who has published tables exhibiting the increase of both, by decades, since 1790. They show that the total population had increased eightfold in 1860; while the average increase of whites by decades was 32·8 per cent, and of negroes 26·8 per cent. In 1790, there were 3,172,000 more whites than negroes; in 1880, 48,575,000; in 1890, probably 58,640,000 more; and if the present relative rates of increase are maintained, there will be, in 1990, 1,067,043,000 more. The estimate should set the apprehension of negro supremacy a considerable distance away.

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* Perhaps the volume of materials required in the manufacture of pig iron may be more readily comprehended by considering that, for the making of a pound of that commodity from the best ore, there are required 1·612 pounds of ore; 0·786 pound of coke; 0·451 pound of limestone; 2·977 pounds of air, or a total of 5·876 pounds of materials for each pound of iron produced.

PRECISION IN PHYSICAL TRAINING.

By M. GEORGES DEMENY.

THE high aim of science should be, definitely, the physical and moral perfectioning of man. The exercise of the cerebral functions of all ought undoubtedly to be directed from infancy by educators. It is generally agreed that physical education is a necessity of hygiene, but it is not clear to every one that physical education should be subjected to rules and to a precise directing. It is a mistake, in our opinion, to think of getting the best results while neglecting to make scientifically a comparative study of the different methods employed, and while abandoning, as is often the case, the exercises of the body to the caprice of the imagination. There result from this vague condition various currents of opinion contradictory of one another and detrimental to the final result proposed, of ameliorating the physical condition of our population, especially of the population at school, of every degree. Fortunately, the elements of physical education are tangible, its effects are measurable, and we can conduct the discussions on a positive ground on which they fall of themselves. This condition is very different from that of mental education. It is a certain motive for improvement; and we purpose to review the precise means which have contributed to the result. We shall first try to show that it is possible to form a scientific conception of physical education at the present time. We shall then see that the new processes of physiology already permit a satisfactory control of its results.

For a method of education to be established, it is necessary that the end sought be well defined, and the means employed be perfectly adapted to the proposed end and compatible with the human organization. The indisputable object of education should be the perfecting of the individual in view of the general progress; it is an economical object, having as its consequence a much greater conversion of human activity into useful work. In physical education it is necessary to apply all the general knowledge we possess concerning the relations between the function and the organ, or rather concerning the modifications endured by the organs, of which we modify the function.

All the ideas acquired by trainers are to be carefully collected; and among modifiers of species, selection must be placed in the first line. Unfortunately, we are still far from the thought of applying to ourselves this powerful agent for improvement, although we impose it on our domestic animals; our own unions are not often made in view of the inheritance of vigor and health which we shall leave to our descendants.

Selection put aside, we have recourse only to exercise and *régime*. The desire to make an athlete of every one must, of necessity, be abandoned. The ideal human type varies with the times; now it is intellectual activity that is in dominant force, and it is not possible to bring muscular work and cerebral work to the front with equal vigor. Physiological knowledge on this subject is extensive enough for us to account for the fact. Cerebral labor is a considerable expenditure of energy, a source of nervous exhaustion quite comparable to the expenditure of energy that accompanies the production of mechanical labor in the muscles; whence we conceive that, beyond a certain amount of physical exercise regulated by hygiene, the total sum of the expenditure of nervous and muscular energy may become excessive and entirely debilitating. It is wisdom to abandon the constant practice of violent exercises; to take deliberate measures to restore athletic brutality would be a remedy worse than the disease. It would also be wise to leave uncalled-for and useless exercises to the circus people.

All exercise which, often repeated, tends to modify the external form and adapt the human organism to abnormal machines or movements, to eccentric attitudes, belongs to the domain of the acrobat, and is of no interest in view of general education. We thus arrive, by elimination, at the point of preserving as materials of the programmes of physical education the general measures which augment the productiveness of man considered as a source of mechanical work, on the condition that those measures do not deteriorate the human machine itself, and do not change the normal relations of that which it has been agreed to call the physical and the moral. Physical education, in short, ought to confirm health, give a harmonious development to the body, and teach how best to utilize the muscular force in the different applications which are demanded in life. We should also have regard to the necessities imposed by the social medium, and try to obtain results by intensive means, requiring little time and little space, and which address a large number at once.

To these three essentials of physical education—health, harmonious development, economical utilization of muscular force—correspond a series of exercises which can not produce their maximum useful effect without being subjected to regulations of which we proceed to sketch the principal features.

Health may be with equal ease confirmed or destroyed by exercise. It is only necessary to refer to the deplorable condition of the ancient athletes, with whom the enormous mass of the muscles absorbed all the activity of the organism. Health, therefore, does not depend on the size of the muscles nor on absolute muscular force. It is the harmony of the functions, and does not exist without a certain daily expenditure of muscular labor. Many persons, it is true, enjoy perfect health without giving themselves methodically up to physical culture; but such persons are easily disturbed by departures from their regular course, or suffer fatigue disproportionate to the effect produced. They can not endure the causes of perturbation, while it is the power to endure that constitutes robust health. It is one of the great benefits of exercise and of *régime* that they give the organism the faculty of accommodation to the diversities of our activity and of the medium that surrounds us. From the hygienic point of view the introduction into our daily habits of exercise in the open air, in the form of various games and sports, can not be too highly commended; but all such exercises, if we wish to make them always efficacious and exempt from dangers, should be subjected to rule.

We can not prudently leave youth without direction to organize competitions, like the race, in which violent exercises figure; it is indispensable to be on guard against the excesses which unrestrained emulation and self-love induce. Without this, exercises, which are salutary when practiced with moderation, degenerate into overstrain of the most dangerous character. We have in this way to regret numerous grave accidents due to colds, troubles of the digestion and the circulation, falls and blows. Under these restrictions, exercise taken under the form of open-air games presents a special attraction to all; it offers the best hygienic conditions; but, to constitute a physical education, it ought also to respond to the desiderata exposed above—the harmonious development of the body and useful application. Further than this, this form of exercise offers in practice, especially in the large cities, difficulties which are often insurmountable, at least for the present. In public instruction, as now constituted, the problem of physical education is very complex; it involves finding means to exercise regularly every day a large number of pupils at once, in a narrow space and a short time. It is in this shape that the question has been put to the ministerial commission charged with revising the programme and the manual of school gymnastics. Every pupil must receive an equal portion of exercise, and often there is only one master to direct from forty to sixty subjects. Large plats of land are needed near the schools, and often they do not exist. To send the children away through narrow,streets crowded with vehicles takes much time, and is dangerous. With all this adjusted, large plats of ground are not enough; ample sheds are needed for open-air exercise. Our climate is not very mild, and if we depend upon the fair days for taking exercise we shall run a great risk of seeing the number of our meetings reduced to an insufficient minimum; for it is not occasionally, but every day, that we ought to take our portion of exercise. Even putting aside the question of time, it is not hard to show that play-hours do not constitute a complete physical education.

There is exercise in play-hours, but there is not, properly speaking, training of the movements; there is no improvement of these movements in view of a useful effect. Each one does not get the portion of exercise to which he has a right. According to the general law, the strongest or most hardy are more benefited than the weaker ones, and the mean level does not rise. Games and sports are still what they have always been—an elegant means, an agreeable form of exercise, the privilege of the easy class, the pleasure of the smallest number. They can not be extended into the working class which is most interested in them, because it is, unfortunately, often obliged to live in bad hygienic conditions.

Even while it is possible, by means of more perfect facilities for communication, to give the children in our schools more frequent excursions in the open air, such excursions will always be rare—once or twice a week at the most, in the large cities. We shall be obliged on other days to have recourse to the processes of a good gymnastics, mere artificial processes, but which have the advantage of being applicable everywhere, and of producing, in the hands of experienced masters, successful results—an artificial remedy in an artificial medium, if we will call it so, and if we can define precisely the boundary between the natural and the artificial.

Let us, nevertheless, use all our efforts to multiply the public places and shelters for the sole purpose of furnishing children and individuals of every class and every age with places designed for exercise in the open air.

The essential factor of physical education is voluntary motion. From the hygienic point of view it is important to have a sufficient amount of exercise to stimulate the combustion in the interior of the organism, and to facilitate the elimination of the wastes of incomplete combustion, which develop into real poisons. From the point of view of harmonious development, not the amount alone of exercise is to be considered, but the form or nature of the movement also; not the quantity, but the quality, too, of the movement is of importance.

Nothing is more malleable than bone and muscle. Trainers, under the influence of movements frequently repeated, transform domestic species by the action of three great modifiers—selection, alimentation, and exercise; every subject devoted to a well-characterized special calling bears the marks of its calling in its structure. We know, in a general way, that under the influence of static efforts the body of the muscles becomes thicker and more salient beneath the skin; under the influence of extended movements, on the other hand, the fleshy substance preserves its length and assumes a relation with the amplitude of the movement.

The articular surfaces are also modified by the latter style of practice, and we see how persons who preferably cultivate exercises of suppleness and quickness present a finer and more elegant form than those who develop athletic force by static contractions. With a similar constitution to begin with, those who devote themselves to practice with weights, with carrying burdens, become more massive than those who practice movements of agility, like fencing and racing. The latter come near the type of the ancient gladiator, the former that of Hercules. Which of them do we consider the more handsome?

The idea of beauty is wholly relative, and varies with places and times. Artists make beauty to consist in certain proportions of the parts of the skeleton and in the harmony of the muscular development. We might, perhaps, be more definite by saying that to be handsome at rest and in motion the man ought to present the traits of health and moderate strength, and in addition to be in possession of his means of locomotion and of natural defense. This view of beauty originates in the consideration that there is a necessary relation between vigor, skill, agility, and the outer form of the body at rest and in motion. Thus defined, the type of beauty, in a given race or medium, is an ideal which we seek to revive by physical education. It follows that a man specially devoted to any one exercise can not be handsome. This may be said of all the professions that localize muscular work in a restricted region of the body. There are, however, some sports that have the advantage of exercising equally the upper and lower limbs; such, for example, as wrestling, French boxing, swimming, and canoeing with two oars and a sliding seat. A good gymnastics includes complete exercises, and incomplete or unsymmetrical exercises, under such a condition as that they shall correct one another, and that the work shall bear upon the lower and upper limbs. An intensive gymnastics well taught produces superb subjects. Swedes, Swiss, and Germans, selected from special schools of gymnastics, and the monitors of the school at Joinville le Pont, might rival the finest types of antiquity. These facts are, unhappily, exceptions; children come to our schools with hereditary blemishes and malformations which the sedentary condition, faulty attitudes, and ill-directed exercises only tend to augment.

If we would come near to the type which we have given ourselves as the ideal one, we must make a judicious choice in gymnastic matters. The form of the curvings of the vertebral column depends on the action of the weight and of the antagonistic muscles that bend and extend it. There is an evident relation between the curves of the vertebral column and the form of the thorax; with large curvatures correspond depression of the ribs, and enfeebling of the thorax and its consequences—obstruction of the circulation and of pulmonary ventilation.

The respiratory capacity of a person does not depend on the absolute volume of the throat, but on the extent to which its volume increases between expiration and inspiration. The lung is the slave of the thoracic wall, and follows it in all its movements. It is constantly kept in contact with that wall, through the action of the atmospheric pressure, which is transmitted to the interior of the bronchiæ, whenever the glottis is opened. Except under stress of effort, we can not imagine the lung pushing upon the thoracic wall to dilate it; the contained has to submit to the variations of the containing. Hence, we have no reason to wonder that gymnasts are soon able, by training, to increase their respiratory capacity by giving, through the motions of the upper limbs, a great mobility to the articulations of the thorax, and thus permitting it to dilate more freely under the action of the elevator muscles of the ribs, to the effect of which is added that of the diaphragm. By strengthening the shoulder and fixing the omoplate with strong muscles, we furnish points of support, in raising the ribs and the flattened thorax. The action of the muscles of the abdominal walls counterpoises that of the extensors of the trunk, and the spine is raised by diminishing its curvatures under the effect of these two kinds of curves acting upon it as upon a bow with two curves. Thus, by perfecting the muscular powers and bringing them into equilibrium, the trunk assumes a good attitude, the chest expands, and the man bears the external indications of vigor and health. All these observations are facts demonstrated and known by practitioners, who have obtained them through good gymnastics. They show that there is a direction to be given to exercises having a good result in view, and that the purpose of physical education will be more quickly attained as the methods are more precise. Stirring around in an indeterminate way is certainly not the shortest and most direct means of obtaining the essential modifications sought for.

We have attached so much importance to that part of the hygiene of exercise that bears upon the form, that we have had constructed at the physiological station, with the assistance of M. Otto Lund, an arsenal of instruments of measurement of a new kind. Some of these instruments give the height, weight, and outline in true size of the fore and back curvatures of the spine; others furnish complete sections of the trunk on a horizontal and on a vertical plane. The measuring-tape gives false indications of the dimensions of the thorax, for its measurements are influenced by the muscular protuberances. We have substituted for gross measurements of the circumference of the thorax those of diameters obtained with compasses and thoracometers specially constructed to give the amplification of the framework of the chest in respiration. With these exact means, and the assistance of physicians who are all interested in these questions, we hope to organize in schools a series of measurements that will cast light on many obscure points. Data are wanting for the definition of the characteristic differences in the form of different subjects whose movements have been accommodated to a special and well-defined profession; and those data in particular are wanting with which to establish the laws of the development of children according as they have or have not been subjected to physical exercise under various conditions. We have begun investigations on this point at the Collége Sainte-Barbe, with the aid of M. Rey, and at the school of Joinville le Pont, with that of M. Roblot. We have found that with growing children the increase of the respiratory capacity is parallel with that of the weight, and has no fixed relation with the stature; and we have shown that the ratio of the respiratory capacity to the weight increases regularly under training. We find also that the absolute dimensions of the thorax do not increase among adults, but that the extent of the movement of the ribs is related to the respiratory capacity. It is, for the same subject, parallel with the quantity of air breathed in. M. Marey showed, some time ago, that the thoracic movements of subjects under exercise are amplified, while their frequency diminishes. Respiration becomes fuller and remains so during rest or after intense exercise. By collating observations bearing on this point, we shall be able to constitute a kind of experimental physiology of exercise, and shall thus have the best and only means of pronouncing without prepossession upon the value, as to the general development of the body, of different methods of education.

We now proceed to examine the tendencies of exercise in view of the economical utilization of muscular strength. The third essential point in physical education consists in establishing the rules that permit the useful and economical employment of muscular force in the various conditions of locomotion, in the management of tools and arms, and in carrying burdens. This is one of the most delicate chapters of animal mechanics. It is the one that is really entitled to be designated the education of the movements, for the educator plays the greatest part in it, and his action is indisputable. When one has devoted himself for a long time to practical exercises of the body, especially to varied exercises, his muscular sense is refined, and he becomes aware of a series of new sensations which remain unknown to those who have never handled tools. In this way we account fairly well for important modifications which are produced in the movements by education.

Absolute muscular force, measured by the dynamometer, soon reaches its maximum, and, if we limit ourselves to this gross measure, we shall have but a false idea of physical perfectionment. It is not, in fact, in the absolute measure of muscular force that a great modification is to be found, but in the aptitude for producing a large sum of work with moderate fatigue and an economical expenditure of force. This refinement is produced in the nervous centers; through attention sustained by the will, through the frequent repetition of well-defined muscular acts, we are able to reach the point of suppressing useless contractions in the desired movement, and bringing into play only a portion of the muscles which were at first contracted in a mass. To this intelligent distribution of the central nervous excitation in the co-operating groups are added a more perfect tact in appositeness, a surer realization of the direction of the intensity and the duration of the contractions, and a greater promptitude in grasping at once all the conditions of the effort. Thus is realized a perfectionment of the motor organs which is manifested externally by address, agility, and sureness of movements, and closely touches upon the higher qualities—confidence in one's strength and courage.

Education should not only be applied to movements of precision, but it ought also to have in view economy in the expenditure of nervous excitation and mechanical labor; it ought to tend to reduce useful contractions to a minimum, and in the end to induce automatism by steadily diminishing the part played by attention, which is absolutely necessary in the beginning. Thus the performing musician is not born a *virtuoso*, he reaches perfection of execution on condition of frequently repeating the same exercises. To acquire perfection of skill, he seeks to obtain equality in the motions of his fingers, ease of hand, arm, and the whole body. He performs the details of a cadence slowly, quickens it progressively, and thus becomes able at last to maintain accuracy in lively movements. Associations of the nervous cells are doubtless produced in his system, which render easy and automatic certain muscular co-operations that were at first insurmountably difficult. The visual perception in the musician comes at last to be translated immediately into a movement of the fingers without any effort of the attention. In the boxer or the swordsman, the slightest manifestation of his adversary's intention produces an instinctive determination which is at once revealed in the attitude.

Normal bearings, like the most complicated movements of gymnastics, are practiced and taught in the same way. There may be an exception in quick movements, such as leaping, which can not be decomposed because they can not be retarded. But skill acquired in difficult exercises creates an aptitude favorable to learning new ones; and it is well known that those who have educated their movements by gymnastics speedily become habituated to the most varied exercises. Yet the skill of a *virtuoso* in any particular art is acquired only by the force of work and patience; and, according to the general law, we are inclined to prize the result of our work according to the quantity of effort it has cost us; in short, to extol the method we have chosen. This is the origin of the schools and of differences in methods, which prevail in gymnastics, as in every other matter—those of Ling, in Sweden; Jahn, in Germany; and Ameros and Triat, in France; and many others who have left various teachings.

Pupils are cultivated by imitation. A group of admirers forms around a chosen person; and among those who seek to imitate him are some who often succeed with great difficulty; the latter are then well disposed to defend their master and their school; they are gratified adepts, who will perpetuate the traditions, with their qualities and their faults. Those minds are rare which can overcome a bad habit when contracted. It is with movements as with moral activity; and that is why every teacher prefers to take his pupils from the beginning, to continuing the labors of his colleagues. It is easily comprehended that the pupil who has contracted the habit of holding his sword in a certain way will find it easier to keep up even a defective attitude, a position that will limit his further progress, than to learn a new one. The effort of attention that he has to make lest he fall back into his false ruts, and to destroy the nascent automatism, is so great that he avoids it. His self-love will not accommodate itself to the idea of becoming a novice, and he prefers going on the wrong way to resuming the toils of first lessons. On these various considerations many practitioners have come really to regard their method as the only good one, and to maintain it, with its errors. But progress in physical education is impossible if we limit ourselves to respect for traditions, to a servile imitation of former things. There can be progress only when we aim at an improvement in attitudes and movements in general. Having been called several times to give our vote in competitive physical exercises, we have been able to observe that the relative merit of the candidates was usually established on conventional bases. Many pupils, who had listened to no other rules than those of nature, and were thus naturally superior, were rated at less than they deserved by judges who were ignorant of these rules. We do not see by what right we should impose laws on the nature of which we are the resultant. If we would make a durable work, our first thought should be to learn those laws, in order to submit ourselves to them more exactly. We should regard it as an axiom that, given the human organization, there could be only one correct solution in any special case of utilization of force. The problem is to find that solution; and to reach this there is, in my opinion, no shorter way than to study in each sport those select subjects, or experts, who have succeeded by practice in excelling in some specialty. We should for that study arm ourselves with precise means of investigation, which will explain the essential principles of their movements, and take these principles as the rules of education. Although these rules have not yet been established, it is not because experts have been wanting; but the most trained eye can not perceive the subtle differences between the means which experts employ for reaching perfection of movements.

It has been necessary, in order to make a further advance in this study, to create processes which have unveiled a new world of facts. It has been the constant purpose of M. Marey to seek, besides purely subjective sensations, certain experimental data, and thus forestall eternal discussions on obscure points of physiology, in which the fundamental basis itself of discussion—facts—was wanting. The services which the photochronographic method has rendered to biology are well known; in the present case, again, it is invoked as a means of correcting errors. The photographic methods in use at the physiological station give, in short, the complete solution of the analysis of motions, however rapid and complex they may be.

By comparing photographic representations of different subjects or of the same subject at different stages of movement, we may exactly define the manner in which they proceed, seize the slightest differences that distinguish their motions, and perceive the least modifications that are produced in their turn. If these all relate to the same type in the process of perfectionment, we are authorized, after eliminating individual variations, to take and teach what Nature has revealed to us. We can thus study expert subjects under two points of view, for the qualities which they present are derived partly from their structure and partly from their education. Everybody walks, runs, and jumps; but there are few who have a passable gait unless they are trained to it. In short, we learn to walk, run, and jump, as we learn all the rest. We can not well learn alone; and it is one of the essential objects of physical education to perfect the normal gaits as well as all the movements in general. It is furthermore important to extend the individual's life of relation and to accustom it to various movements which are of indisputable utility for defense and for personal safety. We can learn to swim and climb only by exercises in swimming and climbing. It is not by running that we learn to overcome the vertigo we feel in lofty places or to extricate ourselves from danger by the strength of our arms.

These truths can and ought to be taught. A considerable portion of them are already popular; some, new or less known, form the matter of the new manual of gymnastic exercises and school plays which the Minister of Public Instruction is about to publish.

However important these tentatives in teaching may be, they are still insufficient. There should be instituted in physical education a special technical teaching in which the mechanism of the movements and their physiology shall be studied with all the development which it permits. On this condition we can raise the level and the return of physical education. We can also by this means introduce ameliorations into manual trades by seeking for a more perfect adaptation of tools to the human organization, and in general the best utilization of muscular force wherever it is called into exercise. This branch is, with hygiene, one of the most useful applications of biological science and touches at many points upon the amelioration of the condition of the laboring classes. While it requires the co-operation of a number of particular branches of knowledge necessitating specialization, its social bearing still deserves to interest special minds and exercise the sagacity of students.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

GREETING BY GESTURE.

By GARRICK MALLERY.

I.

VERBAL salutations have generally been employed to explain those expressed by gesture and posture. The study of ancient literature and of modern travel has furnished many friendly phrases of anthropologic and ethnic interest. But friendly greetings were common before articulate speech prevailed. Sign-language was then the mode of communication, and gestures connected with the concepts and emotions of men preceded and influenced all historic ceremonials of greeting. So it is judicious to resort to gesture-speech, as still found surviving among some peoples and deaf-mutes, for the explanation of the existing and still more of the oldest known forms of salutation, whether verbal or silent. Undoubtedly some of the verbal forms are of recent origin and are independent of any gesture, and such cases require separate discussion; but there are many known instances where greeting is and long has been expressed by gesture without words, and others in which the words used, conjointly or independently, are but derivations from the older, perhaps disused, gestures.

In this application of sign-language the characteristics of that mode of expression appear with distinctness, noticeable among which are the variety of shades of meaning conveyed by substantially the same gesture and the different modes of exhibiting the same substantive concept. Sign-language is more elastic as well as more comprehensive than oral language. Its abbreviation and symbolism are also so clear that linguistic lore and etymologic guess are not needed for their explanation.

The main divisions of the subject to be now considered are—I. Salutations with contact; and, II. Salutations without contact. Under the first division it is convenient to notice successively those directly connected with the sense of—1, touch; 2, smell; 3, taste—although that is not the probable order of their evolution.

Touch.—Under the heading of touch come the personal palpations, such as patting, stroking, or rubbing the head, chest, or abdomen. These are very ancient and wide-spread, but have seldom special significance save as expressive of good-will by seeking to give a pleasurable sensation. Licking sensitive parts with the tongue is in the same category; and most actions of this class may be derived from, or at least explained by, those of subhuman animals.

The abdominal surface was most generally favored, its rubbing being practiced in both hemispheres, and ranging from the Arctic Ocean to Polynesia. Perhaps the notorious fact that eating was often continued to painful repletion, after which friction of the abdomen is a relief, may have some connection with the practice; but it is more probable that it arose from the moderate and agreeable warmth and titillation produced by manipulation of that region. The highest mark of respect in the Mariana Islands was to stroke with the hand the abdomen of the person saluted. The stroking of the exposed surface of that part of a friend's body was symbolized in 1823 by the Eskimos stroking down with their palms the front of their own fur jackets.

But other exposed surfaces received the same attention. When the Kaiowa Satana came back to his wives after a long absence, he said not a word, neither did they, but they stroked his face and shoulders gently with indistinct murmurs of endearment. Livingstone reported that the Zambesi patted the hands of the person saluted.

The Gond people pull the ears of their friends. That familiar performance between the low comedian and the *soubrette* on the stage is probably not immediately connected with the manners of Corea, where, according to H. St. John, "they have no salutations except buffeting each other." The latter may be likened to the proverbial Irish mode of courtship, or with more seriousness to the love-making of lions, where the pat of the paw is subversive.

In many hot regions, markedly in the New Hebrides and New Guinea, actually sprinkling water by the hand over the friend's head is the best expression of friendship. It was symbolized by canoe-men who, on approaching a vessel, sprinkled toward it the sea-water from their paddles, and the significance, if not otherwise known, would be made clear by the spoken words, meaning "May you be cool!" It becomes a question how closely this idea is connected with baptism, and how nearly the old gesture of the hand is preserved in those forms of benediction which are not immediately adopted from the figure of the cross.

In Arabia Petræa the cheeks are pressed together without the use of the lips or hands; and the Indians of Texas in 1685 were noticed to show affection by blowing against the ear. The Biluchi "embrace" by each laying hands alternately on both shoulders of the other. The mutual embrace of affection can not, however, properly be considered as a mere salutation, because it is a communion practiced wholly unconnected with meeting and parting, but it may explain the origin of some of the salutes made with personal contact. Yet certain reports of the occasion and manner of embraces seem to include them among true salutations—e. g., men of the Darling River, when friendly, "salute by standing side by side and casting each of them his nearer arm round his fellow's neck." This suggests the concept of union, though it is more commonly and more conveniently expressed by other actions.

When an Aino returns home after travel, he and his friend put their heads on each other's shoulders; the elder then lays his hand on the younger's head and strokes it down, gradually drawing his hands over the shoulders down the arms and to the tips of the younger's fingers. Until this has been done neither speaks a word. The description would apply to the usual mode of making hypnotic passes. A similar stroking is performed by the Blackfoot Indians of Canada to express gratification.

Other salutes of contact were symbolized by a pantomime in which actual contact was omitted. The Eskimos, as La Potherie told in 1753, "jumped, and rubbed their own stomachs," and the Ainos in informal society stroke their own flowing beards at a visitor, as if to signify, "Consider your beard, if you have any, to be duly stroked."

Some gesture-signs to express friendship are simply symbolic of the actions of friendly greeting. In the remarkable speech of Noaman at Tinicum, on the Delaware River, in the middle of the seventeenth century, he stroked himself three times down his arm, as a greeting of peace, not being able to perform the ceremony to the arms of the auditors. The actions, above mentioned, of the Eskimos in stroking their own bodies and rubbing their own noses, may merely signify that, when they could not get at the proper subjects for nose-rubbing and stroking, they made the semblance of those motions as the sign for their usual physical demonstration of friendship. A case where actual contact and symbolizing appear to be mixed was reported in 1699 by D'Iberville of the Bayogoulas, who first stroked their own faces and breasts, then stroked the breasts of the saluted party, after which they raised their hands aloft, at the same time rubbing them together. The concept of intermingling personalities is indicated. A suggestion of the absorption of happiness through pressure and friction comes from the narrative of Sir John Franklin, as follows: "Whenever Terregannœuck (a Deer-Horn Eskimo) received a present, he placed each article first on his right shoulder, then on his left; and, when he wished to express still higher satisfaction, he rubbed it over his head." This is apparently more than mere taking possession of the article.

Next may be considered the mutual grasp of the hands in greeting. It is difficult to realize that the junction of hands by friends is not instinctive, a physical or sentimental magnetism being so commonly associated with it. Nevertheless, the mutual grasp of hands on friendly meeting, apart from ceremony and symbol, is comparatively recent, and the practice is even yet confined to a limited area. For instance, it appears in Captain Back's Narrative that in 1833 the greeting by union of hands was as strange to the dwellers in arctic lands as their rubbing of noses was to the visitors. Mr. Spencer has published his opinion that the "hand-shake," as the salutation is commonly entitled in English, originated in a struggle, first real, afterward fictitious, in which each of the performers attempted to kiss the hand of the other, which was resisted, thus producing a reciprocating movement. To verify this suggestion it will be necessary to examine into the antiquity and prevalence of the kiss in salutation, which will be considered in its order.

Instances are found for the identical friendly contest for kissing, or priority in kissing, hands, relied on by Mr. Spencer, but they are connected with the topic of precedence as affecting all forms of greeting. Far too much importance is given in the suggested explanation to the shake or motion of the joined hands. The ancient usage, and even that which is now general, is not "hand-shaking" but hand-taking and pressing. The French expressions are "*serrer la main*" and "*donner une poignée*," or more fully "*échanger une poignée de main.*" The translated Gaelic phrase is "Give me the hand," and the German is "*Hand reichen*" or "*Hand geben.*" The quotation so often made from Virgil, where Æneas says to his father Anchises, "*Da jungere dextram,*" indicates only union. It does not appear that any language but English has the familiar and colloquial form "shake hands" or its equivalent, and this is because the hands are not often shaken among other than English-speaking peoples. No more motion is normally employed than is needed to give emphasis, that is, pressure, to the union, and, except when the gesture is made by awkward persons, the pump-handle is not put into operation. Cases of great excitement, real or simulated, formed exceptions, and the ostensible, perhaps ostentatious, motions derived from such exceptional cases must be classed as extrinsic to the intent and unrelated to the origin of the gesture.

When it is considered necessary to do something obvious in connection with the grasp, as if to proclaim that the act of peace and good-will is performed, peoples not of English origin and not under English influence have devices differing from the "shake." On the Niger the ceremony is completed by the two parties taking loose hold of the fingers of each other's hands and then slipping them, making at the same time a snapping noise with the aid of the thumb. In the same region the Lander party complained of being obliged to "crack fingers" along with other ceremonies. According to Schweinfurth, the Niam-Niam and the Monbutto extended their right hands on meeting, "and joined them in such a way that the two middle fingers cracked." The action is essentially not hand-taking, still less hand-shaking, the object being to join in making a noise by the fingers to emphasize union.

A parallel exhibition of the savage idea that satisfaction should not be silent is in the still extant custom of those Bedouins who pride themselves on their breeding. When they sip coffee they make a noise with their lips such as a horse makes in drinking, which among them is the criterion of the man accustomed to the usages of polite society; he who is in the habit of sipping it noiselessly being regarded as a person whose social education has been neglected. The Zuñi and other Indians, whose sole test of festal enjoyment is in repletion, show their gratification by pronounced and elaborate eructations.

It must be noticed that a mutual struggle for the privilege of kissing the hand could only occur in contention of courtesy between equals. It would be a sign of displeasure for the recognized superior to withdraw his hand from his inferior; and special favor was shown in the East, not by withdrawal, but by turning the palm to be kissed sometimes instead of, and sometimes in addition to, the back of the hand, which was normally approached by the lips. It is also clear that the hand-taking or grasping, with or without the shaking, was in its essence mutual, which hand-kissing could not be, as the nearest approach to the idea of mutuality in that action would be its exchange in succession. So Mr. Spencer's explanation does not apply to the great majority of the salutes now in question. It is also necessary to bear in mind that the expression "hand-shaking" as reported by English travelers is deceptive, being, as before explained, a mere term. When detailed descriptions are presented it generally appears that there is no "shake," but a mutual grasp or some other use of joined hands. In the present discussion, therefore, the so-called shake may be dismissed as non-essential.

The Chinese saluter clasps his hands together, holds them out, waves them gently, bends forward, and says, "Chin! chin!" meaning, "Please, please!"—or, less definitely, "Thank you," or "Good-by," as the circumstances explain. In the Society Islands the clasping of hands marked the marriage union or the loving compact between two brothers-in-arms, but had no place in ordinary greetings. Among the North American Indians, and in other parts of the world where, as among the Indians, the hand-grasp in simple salutation has not been found, the junction of the hands between two persons is the ceremonial for union and peace, and the sign for the same concept is exhibited by the two hands of one person similarly grasped as an invitation to, or signification of, union and peace. It must be remembered that among the North American Indians to smoke tobacco is the most common salutation. Indians are at peace only with those with whom they smoke, and to smoke is to make peace. When actual smoking is not practicable the gesture-sign for it is also that for "peace" and "friend." The Cheyenne form is—tips of the first two fingers of the right hand placed against or at a right angle to the mouth and suddenly elevated upward and outward to imitate smoke expelled. Apart from this prevailing sign, one, often made for peace, is by clasping the hands in front of the body, the back of the left hand usually down. Some Indians clasp the hands by interlocking the fingers, holding the forearms vertical. The Sac, Fox, and Kickapoo tribes hold before the body the extended left hand, and grasp it with the right. It is of interest, in confirming the above-mentioned concept of these signs, that since the Cherokees have learned to write in their own language by their own syllabary, they place at the end of their friendly missives the word "*wiguyáligû*," meaning, "I grasp your hand at a distance."

The ideogram of clasped hands to indicate peace and friendship is found in pictographs from many localities. It is possible that the exhibition and presentation of the unarmed hand, to be mentioned in another connection, may have affected the practice, but the probability that the paramount idea was that of agreement is enhanced by a prescribed pantomime of the old Roman law continuing down to the empire from the time of Numa, or the prehistoric lawgivers who were embraced in his mythic personality. The contestants before the legal tribunals were compelled each to offer his right hand for the clasp of his adversary in token of good faith and confidence, before the cause was heard. The same pantomime, pretending honesty of purpose, is obligatory now between prize-fighters, stripped and in the ring, before the first blow can be struck. Support to the hypothesis comes also from a formulary which is still common in Ireland and in some parts of England, of depositing saliva in the right hands and then mutually grasping them to solemnize or cement a bargain.

In several parts of the world the junction is not of the hands, but of some or all of the fingers bent so as to form hooks or links, thus removing from the salutation the suggestion of magnetic pressure and sympathy, and substituting that of mechanical attachment. The Papuans of Torres Strait partially bend the fingers of the right hand and hook them with those of the person saluted, then rapidly jerk the hands apart. This is repeated several times. Schweinfurth describes as general in Africa the hooking of the middle fingers, and their violent jerking, often causing the "crack" before mentioned. The Dakota sign for "friend" is to point forward and a little upward with the joined and extended fore and middle fingers of the right hand, which is about a foot in front of the right breast; move the hand upward to the right side of the face, then straight forward about eight inches, and then a little upward. Thus a hook is pictured in the air. Or the bent right index, palm downward, is hooked over the bent left index, palm upward, the hands about a foot in front of the body. The Southern Indians frequently link their index-fingers in front of the body to express friendship. A more emphatic sign made by the Comanche is to bring the two hands near each other in front, and clasp the two index-fingers tightly, so that the tips of the finger and the thumb of each hand touch, thus forming two distinct and united links.

The Delaware Noaman, in his speech at Tinicum, made the sign for friendship in special connection with alliance "by the semblance of making a knot." The etymology of alliance from *alligare*, to bind to, is at once recalled. Some deaf-mutes in the United States interlock the forefingers for "friendship"; clasp the hands, right uppermost, for "marriage"; and make the last sign, repeated with the left hand uppermost, for "peace." The idea of union or linking is obvious. Other deaf-mutes, to express friendship, link the index-fingers twice, first holding the left hand back down and then turning it back up.

In this connection it is to be noted that the Japanese, in actual salutation, not merely as a sign of it, only indicate the hand-grasp. They fumble with their own hands in greeting, instead of troubling those of the person greeted, which is a proof of their refinement, deserving of imitation in the United States, where the continual and promiscuous hand-taking, which often is hand-shaking, is a serious nuisance, and is properly ridiculed by foreign visitors. The habit, however, is not peculiar to the United States, most Teutonic peoples having the same and being also ridiculed by the French. The Chinese, with a higher conception of politeness, shake their own hands. The account of a recent observer of the meeting of two polite Celestials is: "Each placed the fingers of one hand over the fist of the other, so that the thumbs met, and then, standing a few feet apart, raised his hands gently up and down in front of his breast. For special courtesy, after the foregoing gesture, they place the hand which had been the chief actor in it over the stomach of its owner, not on that part of the interlocutor." The whole proceeding is symbolic, but doubtless is a relic of objective performance. The Chinese symbol for friend, *dok*, is two hands.

Some writers have conjectured that the custom of giving and taking hands is derived from the giving and taking of presents, often an obligatory act of friendship. In several countries objects, perhaps of no value, must always be exchanged on the meeting of friends. To offer, accept, or refuse a hand undoubtedly has import, independent of the manner of junction. Other suggestions have been made to the effect that the hand-grasp was symbolic of the action by which physical help is frequently rendered, as by raising up a comrade who has fallen into a hole. A more poetical concept is clearly indicated in the Oto addition to the common sign for friend: Both hands are brought open before the chest, then extended, and the left hand, with palm up, is grasped crosswise by the right with palm down, and held thus several seconds. The hands are then unclasped, and the right fist is held in the left axilla, by which it is firmly grasped. "One whom I will not let go."

Indians have another mode of expressing "union," "friend," and specifically "brother," and "growing up together." They hold the right hand in front of and back toward the neck, index and second fingers extended, touching, pointing upward and slightly to the front, the others and thumb closed; raise the hand, moving it slightly to the front until tips of fingers are as high as the top of the head; or the index-fingers of both hands may be used similarly.

A form of expressing friendship accompanied by adoption was reported in 1837 from a Texan tribe. The oldest chief took the white visitor "by the right hand and commenced a sort of manipulation up the arm, grasping it strongly, as if feeling the muscles at short distances quite up to the shoulder." The visitor was obliged to do the same to the chief, and to exchange the same ceremony with all the other chiefs. The Murray-Islanders of Torres Strait do not clasp hands, but each gently scrapes with his finger-nails against the palm of the other's hand. These performances remind of certain secret society "grips," and they may have been absolutely on that principle, as many American and some Polynesian tribes have mystic, generally religious, secret societies similar to those of Europe and Asia.

A curious custom of the Ainos may be explained either on the theory of magnetic rubbing or on that of producing union by trituration: A strange Aino is received by the head man of the village visited. Both kneel down, and, laying their hands together, rub them backward and forward. Neither says a word before the ceremony is completed.

SMELL.—The sense of smell, though intimately connected with that of taste, is remarkably acute among the lower tribes of men, therefore probably its exhibition in gesture-speech is at least as ancient as the similar exhibition of the sense of taste.

Smelling and sniffing come early among known salutations, and are still common. Those actions among subhuman animals on their meeting are so well known that comparison is needless. The wants and habits of civilized but not thoroughly cultured life have diminished the functions of smell, and tobacco-smoking, among other usages, has impaired its organs. But relics of the importance once attached to smell are yet found. In Siam there is a rule which might be imitated to advantage. On the approach of an inferior the superior sends one of his attendants to examine whether the visitor has eaten or carries with him anything of an offensive odor. If so, he is refused admission. A remarkable contrast to most of the American Indians regarding scents has lately been reported from British Columbia. Immediately before the expected arrival of friends the tribesmen clean their habitations and bathe, so that no bad odor remains to offend the guests. They also take repeated baths before religious ceremonies, so that their redolence may be agreeable to the Daimon invoked. This concept recalls the still existing Gaelic belief that the fairies are pleased by sweet odors and cleanliness, and are driven off by the opposite. Neither of these examples relates to the use of any ceremonial perfumes, such as incense, which, indeed, was designed to affect the worshiper.

The junction of noses is so general, and described as so forcible in Africa and Oceanica, as to have given rise to a fanciful theory that it had occasioned the flattening of the noses of the peoples. But in the accounts of many of the tribes of the Dark Continent and of the islanders of New Zealand, Rotouma, Tahiti, Tonga, Hawaii, and other groups, the essential action does not seem to be that of either pressure or rubbing, but of mutual smelling. It is true that the travelers generally call it rubbing, but the motion and pressure are sometimes no greater than that of the muzzles of two dogs making or cementing acquaintance. The pressure and rub are secondary and emphatic. The juncture only means the compliment, "You smell very good!" It is illustrated in the Navigator group when the noses of friends are saluted with a long and hearty rub and the explanatory words "Good! very good; I am happy now!" The Calmucks also go through a suggestive pantomime of greeting in which they creep on their knees to each other and then join noses, as much as possible like the two dogs before mentioned. In the Navigator Islands only equals mutually rub their noses. The inferior rubs his own nose on and smells the superior's hand. The respectful greeting of Fiji is to take and smell the hand of the superior without rubbing it. In the Gambia when the men salute the women they put the woman's hand up to their noses and smell twice at the back of it. In the Friendly Islands noses are joined, adding the ceremony of taking the hand of the person to whom civilities are paid and rubbing it with a degree of force upon the saluter's own nose and mouth. The Mariana-Islanders formerly smelled at the hands of those to whom they wished to tender homage. Captain Beechy describes of the Sandwich-Islanders: "The lips are drawn inward between the teeth, the nostrils are distended, and the lungs are widely inflated; the face is then pushed forward, the noses brought into contact, and the ceremony concludes with a hearty rub."

Sometimes the smelling and the nose-rub are not mutual, being successively exchanged. The Chittagong-Hill people and the Annamites place the nose upon the friend's cheek and inhale through it strongly. They ask not for a kiss, but for a smell. The Khyoungtha of eastern India apply the mouth and nose to the cheek and give a strong inhalation. The Zuñi clasp hands and alternately carry the hand of the friend to the mouth and inhale it. They neither kiss nor smell, but, as they say, "exchange the breath of the life." This action has been erroneously reported as hand-kissing; and several of those above mentioned, which are accurately described as joining the noses and smelling the cheek or hand, have been mistaken for the kiss, either mutual or single.

A tribe of the Eskimos was described by Captain Ross as pulling their own noses for greeting, which he thought had reference to the application of snow as a cure for the frost-bite. It might occasionally have been a signal or warning to a friend that his nose required snow, but as a greeting it was merely symbolic of the rubbing or pressing of noses common both in high and low latitudes. This pressing itself is abbreviated or perhaps indicated in New Guinea by friends simply touching with the hand the tips of their respective noses. The Todas, in respectful address and on approach to sacred places, raise the thumb-edge of the right hand vertically to the nose and forehead. This probably is the gesture of an imprecation—the penalty being that the head may be split open—and has no connection with either smelling or with rubbing the nose, though easily mistaken for those actions. Another symbolic gesture of salutation which is given by the Aino women between themselves may be mentioned. They draw the forefinger of the right hand between the forefinger and thumb of the left, then raise both hands to the forehead, palms up, and then rub the upper lip under the nose with the forefinger of the right hand. This might be translated as expressing admiration for the good odor imputed to the other lady.

TASTE.—After smelling, the gustatory employment of the lips comes in order of time and of culture planes. Regarded merely as a salutation, the kiss seems to have been used between men before it was applied between the sexes—e. g., Cyrus kissed his grandfather in formal reverence "because he wished to honor him." But perhaps this distinction was only because there was no public salutation adopted for men to women, on account of woman's greater seclusion. In the old days the women were regarded as inferiors, and the erect posture required for a mutual and ceremonial kiss in public was subversive of some regulations concerning superior and inferior to be discussed later. The practice of kissing between males, seeming to cultured peoples ludicrous if not disgusting, is still common in continental Europe and in other less civilized regions, but it is seldom performed by the two pairs of lips. The lips of one or successively of both actors are generally applied to the cheek. But sometimes, when kissing the cheek has been reported, the action was in fact misunderstood. In addition to the instances mentioned elsewhere, this error would naturally attend the "blowing upon our ears," as narrated by Joutel of the natives of Louisiana in 1685. Also to-day in Arabia, indeed commonly in the Orient, the lips are applied to the flowing ends of the saluted man's beard. These appendages, to which veneration is always attached, are solemnly raised to the saluter's mouth and kissed. That was the treacherous salutation of Joab to Amasa.

The mutual kiss of affection or passion by the lips between persons of opposite sex is generally considered to be instinctive. Reichenbach sought to explain it on the theory that the mouth was the focus of his "odic force," and that these two foci of opposite sexes possessed natural attraction to each other. The hypothesis that the kiss is to be derived from the mutual licking of each other by the subhuman animals is unsatisfactory, because those animals seldom bring the soft parts of their respective mouths into contact. They exchange licking as they exchange rubbing of other parts of the body, and such lickings and rubbings are unrelated to sex. But the fact that the mutual kiss between opposite sexes is not general among the tribes of men is abundantly shown by the observations of travelers in the lands where savagery and barbarism still exist. Where it is now practiced it is not probably of great antiquity. In some languages, notably the Japanese, there is no word for kiss.

When, however, the kiss was introduced to include women, its vogue, like that of other new inventions, was carried to excess. According to the chronicle of Winsenius, it was unknown in England until the Princess Rowena, the daughter of King Hengist, of Friesland, instructed the insular Vortigern in the imported salute. Though the Saxon statistics are not probably exact, it is historical that in England, not many generations ago, it would have been the imperative duty of a visitor to have kissed all the ladies of the household, even without previous acquaintance. Such was the experience of many surprised literary foreigners, notably Erasmus. The contemporary drama shows the usage to have lasted into the Georgian era, and it is to be noticed that the performance was generally called a "salute," sometimes "the salute."

The history of the early Christian Church affords instruction on this topic. At first the kiss was an adopted sign of fellowship —"Greet all the brethren with a holy kiss" (1 Thess., v, 26). It early passed into ceremony as the kiss of peace given to a newly baptized convert, and in celebrating the Eucharist. But, as it was found to have some qualities not adapted to religious and spiritual use between the sexes, it was ordered that only men should kiss men and women only women. The awkwardness of this practice, or perhaps the experience that promiscuous kissing, even when limited to the same sex, was liable to convey contagious diseases, induced another amendment, by which the ceremonial kiss in the Roman Church was only passed between the ministrants, and a relic or cross called the *osculatorium* or *pax* was passed to the people for their lips.

It may, perhaps, be suggested that one reason for the very long delay in the practice of the mutual kiss was in the general use by one or both of the sexes of nose-rings or labrets, either of which would prevent the approximation requisite. If such use be not admitted as a *causa sufficiens*, it at least affords evidence that the kiss was not customary among the people by whom nose-rings and labrets were worn. Indeed, Prof. Dall gives instances where, labrets being common and the kiss unknown, the tongues are protruded in affectionate salutes.

The kiss of the hand is undoubtedly ancient, and therefore is not derived from that of the lips, but probably the converse is true. The hand-kiss is loosely asserted to be developed from servile obeisances in which the earth, the foot, and the garments were kissed, the hand and cheek succeeding in order of time and approach to equality of rank. But it is doubtful if that was the actual order, and it is certain that at the time when hand-kissing began there were less numerous gradations of rank than at a later stage. Kissing of the hands between men is mentioned in the Old Testament, also by Homer, Pliny, and Lucian. The kiss was applied reverentially to sacred objects, such as statues of the gods, as is shown by ancient works of art, and also, among numerous etymologies, by that of the Latin word *adoro*; and it was also metaphorically applied by the inferior or worshiper kissing his own hand and throwing the salute to the superior or statue. In republican Rome kissing the hands of superiors was common, but the greeting was more energetic than the emperors could endure, and soon courtiers of even important station were compelled to kneel and with the right hand carry the hem of the emperor's robe to their lips. Even this became a too precious, or, through proximity, a too dangerous privilege, and they were only allowed to salute at a distance by kissing their own hands, as when they adored the gods. This sign of Rome's decadence has survived in the locality. The mouth kissing the hand, by which Job described a species of idolatry, is a species of adulation practiced by every cringing servant in Italy. When the actual practice has ceased, it survives in phrases. Austrian men habitually say to one another, "*Küss d'Hand!*" and Spaniards "*Beso á Vd. los manos!*" A variant form was found among the Algonkins and Iroquois, as Champlain related, in 1622, that "they kissed each his own hand and then placed it in mine."

Affection, together with respect, is sometimes shown in the Orient when a servant salutes a master, a son his father, or a wife her husband, by kissing the other's hand either on back or palm or both and then carrying it to the kisser's forehead. Among the Malays the visitor approaches the man he wishes to salute with his hands joined as if in supplication, while the other touches them lightly with his own on either side, and afterward raises his hands to his lips or forehead. These motions are similar to the ceremonies in the feudal acts of homage and fealty. The

Micronesians, notably in the Pelew and Caroline Islands, took up either the hand or foot of the party respected and rubbed their own faces with it. Some religious sects—e. g., the Dunkers—also kiss one another's feet—after washing them.

The original concept expressed by the hand-kiss was that of "good." In very early times to possess what had a good taste was of the greatest importance to man, and therefore a good taste was the symbol of any good thing or person. So, when practicable, the hand of the person saluted was carried to the lips to signify that he was good. This act is naturally accompanied by the bowing of the head. The common gesture-sign for "good" in all senses is to carry the hand to and from the lips with a pleasant expression. The spontaneous expression of deaf-mutes is much the same, signifying not only greeting, but satisfaction, in short—good. Their full sign is described as "touch lips with palm or ends of fingers pointing upward, then wave the hands outward to the right and downward, turning palm up." This is a complete description of kissing one's own hand, but it has no relation to the kiss by the pairs of lips.

A common gesture-sign for "peace," the idea of friendship being more directly connected with that of "quiet," is made by placing the forefinger on the lips, which sign has often been erroneously reported as a kiss. Still another Indian sign, similar in motion and in conception, is that which, with variant emphasis and expression, means admiration, or surprise, or a high degree of content. Its essence consists in placing the hand upon or over the mouth, that being sometimes closed and sometimes open, though covered by the hand with rapid emphasis. In the former case it is interpreted to mean that language is inadequate to express the sensations felt. When the mouth is open, with the hand placed over it to attract notice, the sign represents surprise by imitation of the familiar and instinctive action attending that emotion. This sign also has been reported as a kiss of the hand.

Another case where the same error might readily have occurred is also of interest, as showing a contrast with the Zuñi inhalation, giving an equally poetical concept. In equatorial Africa the hands of the person saluted are blown upon, with the words, "Let it be as smooth with you as the breath I blow on your hand."

Mr. W. T. Wyndham admires the skill with which the aborigines of Australia use stone implements, and turn out work that one would hardly believe possible with such rough tools. They show great ingenuity, particularly in making their harpoon-heads for spearing dugong and fish; instead of shaving the wood up and down as a European workman would do, they turn it round and round, and chip it off across the grain.

PROGRESS IN AGRICULTURAL SCIENCE.

By Dr. MANLY MILES.

THE progress recently made in tracing the interdependent relations of living organisms is clearing up some of the obscure problems in the nutrition of plants that have a direct bearing on the processes of evolution and the applications of science in agriculture.

Since the discovery of the composition of the atmosphere, the problem of the sources of the nitrogen of vegetation has given rise to a wider range of experimental investigation and discussion than any other in vegetable physiology. The evidence appeared to be conclusive as to its source in certain families, including the cereals, while the larger supplies of nitrogen obtained by leguminous plants were not fully accounted for.

The experiments of Boussingault, in France, and the elaborate investigations at Rothamsted, in England, seemed to show that atmospheric nitrogen is not appropriated, to any extent, by the leaves of plants, and that the soil is the main or sole source of the nitrogen of vegetation.

Wheat and barley were the leading cereals under experiment, as field crops, at Rothamsted; and it was found that, while they contained less nitrogen in their composition than leguminous crops, they were specifically benefited by nitrogenous manures. On the other hand, leguminous crops, which obtained larger supplies of nitrogen from the soil, were not benefited by nitrogenous manures, and they grew luxuriantly on soils that did not furnish the cereals with their comparatively limited supplies of nitrogen.

These apparently paradoxical results are now explained, in part at least, by investigations made within the past five years by Hellriegel and Willfarth, Ward, Prazmouski, and others, which have been fully verified by experiments at Rothamsted which are still in progress. Former experiments showed that leguminous plants obtained nitrogen from some source, or under conditions that were not available for the nutrition of the cereals, and it was evidently not obtained from the atmosphere.

It was suggested that the tubercles observed on the roots of leguminous plants had a direct relation to the appropriation of nitrogen; but most observers looked upon them as abnormal and of no physiological significance.

The latest investigations, however, show, beyond the shadow of a doubt, that these "tubercles" or "nodules" are the results of infection by microbes, and that "the relation between the roots and the bacterial organisms is a true symbiotic one, each developing more vigorously at the expense of the other," and that free nitrogen is appropriated by the microbes.

In 1883 Hellriegel began experiments with leguminous plants in pots of washed quartz sand, to which no nitrogen was added. Marked differences were observed in the growth of the plants under these conditions, but tubercles were found on the roots of the plants that made the best growth, while they were absent in other cases. He was then led to attempt the production of the root-tubercles by seeding or inoculating sterilized sand with a water-extract of a soil in which leguminous plants were growing. To some of the pots, in which peas and vetches were planted, from twenty-five c. c. to fifty c. c. of a water-extract of a fertile soil were added. When this soil-extract was not sterilized, there was a luxuriant growth of the plants in the pots to which it was applied, with abundant formation of root-nodules; but when the soil-extract was sterilized, this result was not obtained.

This soil-extract, however, was without effect on lupines and some other plants; but when the lupine pots were inoculated with an extract of a soil in which lupines were growing, the plants made a luxuriant growth, and root-tubercles were abundantly developed. In all cases the nitrogen supply of the plants was coincident with the development of root-tubercles, that were produced by inoculation with the extract of a fertile soil.

In 1888 a preliminary series of experiments, on the same lines, were begun at Rothamsted by Sir John B. Lawes and Prof. J. H. Gilbert; and in 1889 they were continued, on a more extended scale, with modified conditions suggested by the results of the preceding year. Their first experiments were made with peas, blue lupines, and yellow lupines, in pots seven inches high and about six inches in diameter. For our present purpose we need only call attention to the experiments in 1888 with peas.

Pots 1, 2, and 3 were filled with a washed yellow sand, to which was added 0·5 per cent of the ash of pea plants to furnish the required mineral constituents. Pot 4 was filled with a rich garden soil. Distilled water was used for watering the plants, and no other application was made to pot 1. Care was taken to determine the nitrogen of the soils, and of the seeds planted, which we need not describe in detail.

An extract of a rich garden soil was prepared by shaking in a stoppered bottle one part of soil with five parts of distilled water, and, after the coarser particles had subsided, twenty-five c. c. of the liquid was applied to each of pots 2 and 3. A chemical analysis of this soil-extract showed that the amount of plant food contained in it was so small that it could be safely neglected as an element of plant growth, and that its effect must be attributed solely to the soil microbes it contained.

There was a considerable development of roots in the upper part of pot 1, and a number of root-tubercles were formed, owing to the fact, as proved by subsequent experiments, that the sand was not sterilized before planting the peas. The roots in pots 2 and 3, inoculated with soil-extract, were more abundant than in pot 1, and the root-tubercles were decidedly more numerous and frequently in clusters. The above-ground growth was more luxuriant in pots 2 and 3 than in pot 1, and "in the total vegetable matter there was in pot 2 more than twice, and in pot 3 nearly twice as much, nitrogen as in pot 1 without soil-extract."

A comparison of the total nitrogen in the soil and plants at the close of the experiment with the original nitrogen in the soil and seeds showed that "in pot 1, with the impure and not sterilized sand, but without soil-extract, there was more than three times as much nitrogen in the products as in the soil and seed; in pot 2, with soil-extract, there was about five times as much; and in pot 3, also with soil-extract, there was more than four times as much." There was very little difference in the amount of nitrogen in the soils at the beginning and the close of the experiments, and, neglecting this, it appears that "the nitrogen in the substance grown was, in pot 1, nine and one half-fold; in pot 2, nearly eighteen-fold; and in pot 3, nearly fifteen-fold that supplied in the seed."

In 1889 similar experiments were made with peas, red clover, vetches, blue lupines, yellow lupines, and lucern. For the lupines and lucern glazed earthenware pots, six inches in diameter and fifteen inches deep, were provided, and for the other plants the same pots were used as in 1888.

"The sand used was a rather coarse white quartz sand, from which the coarser and the finer portions were removed by sifting, and more of the finer by washing and decantation, first in well, and afterward in distilled water.

"In each case the sand was mixed with 0·1 per cent of the plant-ash, and 0·1 per cent of calcium carbonate." The prepared sand was sterilized by keeping it for several days at a temperature of nearly 100° C. in a water-bath.

"There were four pots of each description of plant." Of the peas, clover, vetches, and lucern there was one pot of each of the prepared quartz sand without inoculation with soil-extract; two pots of the prepared quartz sand inoculated with the microbes of a garden-soil extract; and one pot of garden soil itself. Of the blue and the yellow lupines there was one pot of each of the prepared, but not inoculated, quartz sand; two pots of the prepared quartz sand inoculated with an extract of a soil from a field where lupines were growing; and one pot of the lupine soil itself, to which was added 0·01 per cent of lupine plant-ash.

"The soil-extracts were in all cases added on July 9th, before the sowing of the seed; twenty-five c. c. in the case of the peas, the vetches, and clover, and fifty c. c. in that of the lupines and lucern. The seeds, carefully selected and weighed, as in 1888, were sown on July 10th—that is, about four weeks earlier than in the previous year, but still not as early as was desirable."

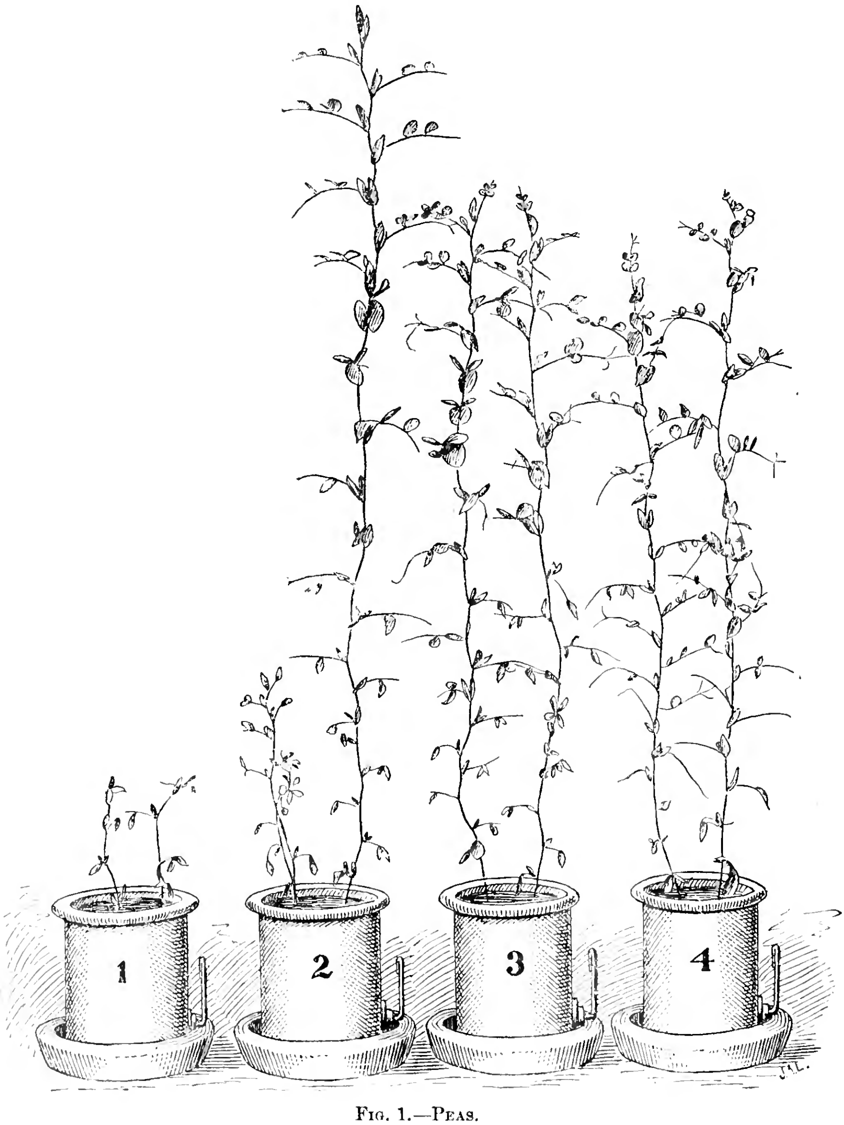

Fig. 1.—Peas.

Ten seeds of clover, three of the lupines, and two each of the peas, vetches, and lucern, were put in each pot. "No analytical results of the experiments of 1889 are as yet available," and we can only notice the relative growth of the plants under the different conditions. The pots of clover and lucern were left for a second year's growth, and their roots could not, therefore, be examined. A photograph of the four pots of peas was made October 22d (a copy of which is given in Fig. 1), and the plants were taken up for examination October 23d and 24th.

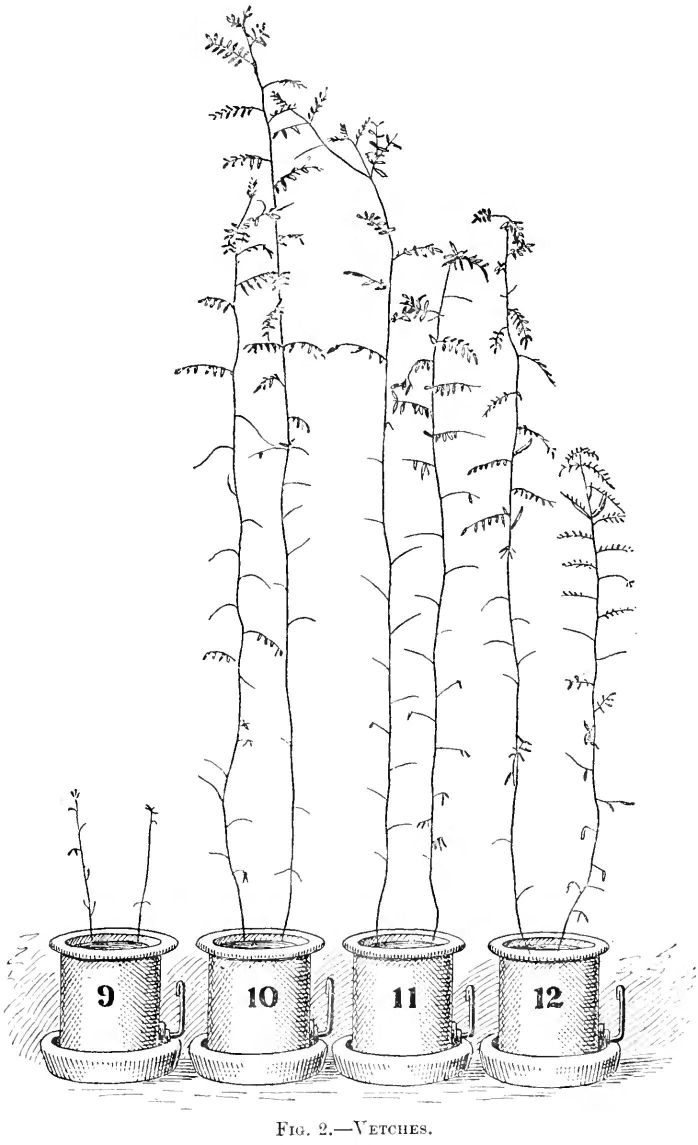

FIG. 2.—VETCHES.

The relative growth and development of the plants in the different pots are clearly shown in the photograph. "Unlike the result obtained in pot 1 in 1888, with the impure and non-sterilized sand, the plants in the purer and sterilized quartz sand (pot 1,

Fig. 1) show extremely limited growth." The plants in pots 2 and 3, inoculated with a soil-extract containing microbes, began to show enhanced growth, when compared with the plants in pot 1, before the end of July. Finally, the plants in pot 1 were eight inches and a quarter, and eight inches and a half high; in pot 2, fourteen, and fifty inches and a half; in pot 3, fifty-two inches and a half, and fifty inches and a half; while in the garden soil, in pot

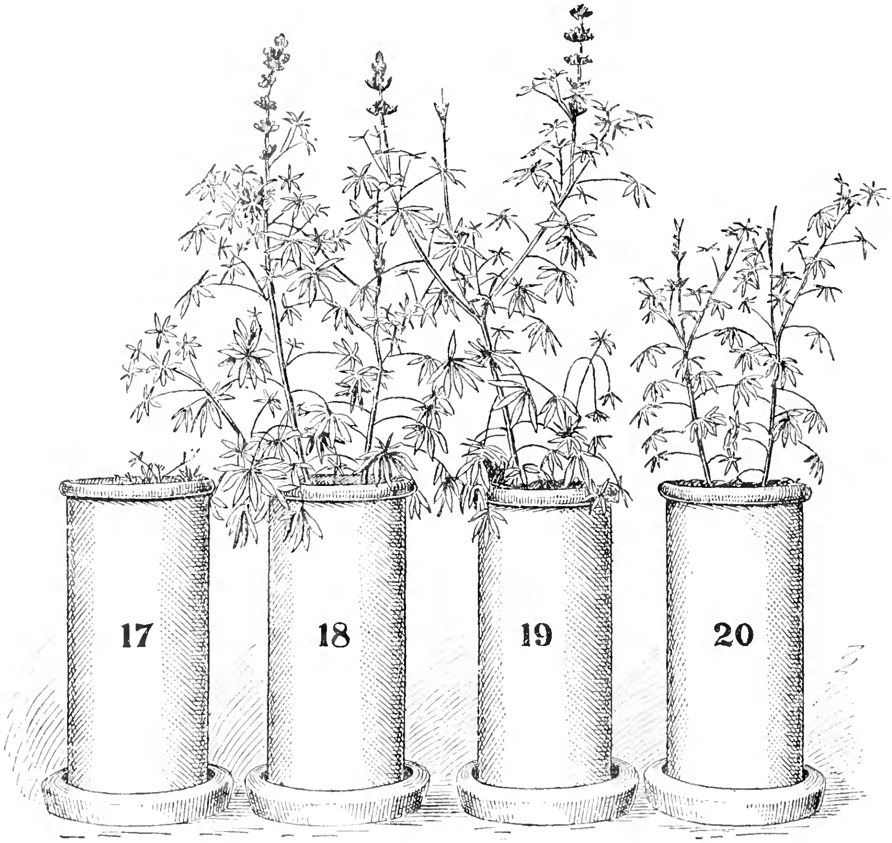

Fig. 3.—Yellow Lupines.

4, they made a somewhat less extended growth than those in pots 2 and 3 in a sterile sand inoculated with soil-microbes. It should be remarked, however, that "the plants in pot 4 were more vigorous, and, while they flowered and seeded, neither of those in pots 2 or 3 did so."

A photograph of the vetches was taken October 25th (a copy of which is given in Fig. 2), and they were harvested for examination the following day. The plants in pot 9, which was not inoculated with soil microbes, were eleven inches and a quarter, and ten inches and a half high; those in pot 10, in a sterile but inoculated quartz sand, were fifty-two inches and a half, and sixty-seven inches high; those in the duplicate pot 11 were sixty-one inches and a half, and fifty-one inches high; while those in pot 12, in a garden soil, were only fifty-three, and thirty-six inches high. As in the case with the peas, the plants in pot 12 flowered and seeded, while those in pots 10 and 11 did not.

Most of the blue lupines, as in 1888, failed to grow. After some reseeding two plants of yellow lupines were grown in each pot. Their relative development, November 29th, is shown in the photograph copied in Fig. 3.

The plants in pot 17, in the sterilized sand not inoculated with soil-microbes, were one inch and a half, and two inches high, "scarcely showing over the rim of the pot"; those in pot 18, in the inoculated quartz sand, measured twenty-four, and eighteen inches, "both spreading much beyond the width of the pot"; in pot 19, also in inoculated quartz sand, one plant was more than two feet and the other but little more than eight inches high; while in pot 20, in a soil from a field where lupines were growing, one plant was but sixteen inches and the other only eighteen inches high, and both less branching than those in pots 18 and 19.

"Unlike the peas and vetches, the yellow lupines, with soil-extract seeding (pots 18 and 19, Fig. 3), flowered and podded freely. One plant in pot 18 had nine small pods, and one in pot 19 four large and three small ones. There were also in pot 20, with lupine soil, on one plant five pods and on the other six. Thus, in the quartz sand with lupine soil-extract seeding, the plants not only produced a great deal more vegetable matter than those in the lupine sand itself, but they as freely flowered and seeded." This was probably owing to the less porosity of the lupine soil when watered in the pot.

The root development and root-tubercles in the different pots may be briefly described as follows: In pots 1 of the peas, 9 of the vetches, and 17 of the lupines, *no root-tubercles could be found,* and the roots were decidedly less developed than in the inoculated pots 2, 3, 10, 11, 18, and 19.

In pot 4 of the peas in the garden soil the roots were abundant, but the root-tubercles were not as numerous as in pots 2 and 3. In pot 12 of the vetches, also with garden soil, the root-tubercles were less numerous, and the roots were not as well developed as in pots 10 and 11. In pot 20 of the yellow lupines, in a soil from a field where lupines were growing, the root-tubercles were not as numerous, and there was less root development than in pots 18 and 19.

In their "preliminary notice" of the results of these experiments, Sir J. B. Lawes and Prof. J. H. Gilbert say: "It will be admitted that the results so far brought forward are abundantly confirmatory of those obtained by Hellriegel; and that the fact of the fixation of free nitrogen in the growth of *Leguminosæ* under the influence of microbe seeding of the soil and of the resulting nodule formation on the roots may be considered as fully established."

The results obtained by the inoculation of the prepared quartz sand with the microbes of a fertile soil, or of one in which lupines were growing, as shown in the increased growth of the plants in pots 2, 3, 10, 11, 18, and 19, when compared with those in pots 1, 9, and 17, which were not inoculated, are striking; but a comparison of the plants in the inoculated pots with those in pots 4 and 12 in a garden soil, and pot 20 in a "lupine soil," furnish still more significant indications of the futility of purely chemical considerations in discussing the nutritive processes of plants and their relations to the soil. The peas and vetches in a rich garden soil flowered and seeded, but the plants were not as large, and the root-tubercles were not as numerous, as in the sterile quartz sand inoculated with microbes from a fertile soil; and the lupines made a better growth in the inoculated quartz sand than in soil from a lupine field.

The biological factors concerned in the elaboration of plant food seem to be quite as important as the chemical elements provided in the soil itself; and a revision of the accepted theories of plant growth, and the relations of soils to their processes of nutrition, is evidently needed from this standpoint.

It should be remarked, however, that the root-tubercles produced by microbes are not confined to the *Leguminosæ*, as they have, in fact, been observed in several natural orders of plants. Moreover, there are indications that several varieties or species of symbiont microbes are concerned in the production of tubercles on the roots of leguminous plants, and it is probable that each species has its own favored form.

Hellriegel failed to grow lupines in a nitrogen-free soil inoculated with a fertile soil-extract; but, when the inoculation was made with an extract of a sandy soil in which lupines were growing, a luxuriant growth was obtained.

In the Rothamsted experiments on land where red clover had been grown repeatedly, and its yield of nitrogen was reduced to but 22 pounds per acre, vetches, on an average for three years, obtained 120 pounds of nitrogen per acre; lucern yielded as high as 340 pounds, and made an average for six years of 150 pounds of nitrogen per acre; and Bokhara clover yielded crops of 130 and 145 pounds of nitrogen per acre. On land where beans had been grown almost continuously for thirty-two years, and had "practically failed" to grow, their yield of nitrogen per acre having been reduced to about 16 pounds on the unmanured plot, and less than 27 pounds on the plot with mineral manure but without nitrogen, very large crops of red clover were grown containing about 300 pounds of nitrogen per acre.

If attention is directed exclusively to the root-tubercles of plants and the roots to which they are attached, it is difficult to understand the manner in which the free nitrogen of the air permeating the soil is made available by the microbes for the nutrition of the more highly organized hosts with which they are associated; but the problem is simplified when we take into consideration the interdependent relations of living organisms arising from their habits, and different requirements in their processes of nutrition.

The influence of cats on the growing of clover seed, as pointed out by Darwin, furnishes a good illustration of dependent relations in the struggle for existence. Cats prey on field-mice that destroy the nests of humble-bees, and the bees are known to be important factors in the fertilization of the clover plant. Quite as marked relations of dependence have been observed among microbes, but the sequence of organisms may be brought about by a different process.

In the ordinary processes of putrefaction we find an orderly succession of living organisms engaged in the work of disintegration in which relations of dependence are clearly manifest. The microbes that initiate the putrefactive process appropriate the materials required for their own growth and multiplication, and the residual mass soon becomes better fitted for the nutrition of other species which succeed them. These are, for similar reasons, succeeded by other forms that are better adapted to the changed conditions, and a series of organisms, of diverse habits, is required to reduce the organic compounds to their elements. Each species performs a specific *rôle*, "the earlier ones preparing the pabulum, or altering the surrounding medium, so as to render it highly favorable to a succeeding form," while their own activities are checked by the changed conditions.

The term *symbiosis*, as now used, is limited to the immediate and direct relations of certain species that are mutually beneficial in their processes of nutrition and growth; but this interdependence of vital activities and interests, in many cases at least, seems to extend to more remote relations through a series of organisms, each of which may have an influence on the well-being of the others. An increased growth of clover in a nitrogen-free soil has been obtained by seeding it with an extract from a root-crop soil; and this, in connection with the facts already presented, is certainly suggestive in explaining the advantages arising from crop rotations.

The micro-organisms that are found in great variety in soils must have an important influence on the processes of metabolism that are constantly taking place in the soil itself; and the results of their activities, which are not limited to processes of putrefaction and nitrification, can not be measured solely by the amount of nutritive materials appropriated. In my own experiments with soil-microbes they have proved their ability to take their required supplies of lime and potash from solid fragments of gypsum and feldspar, and even from the glass tubes in which cultures were made, which were deeply etched by their action.

The roots of plants undoubtedly aid in determining conditions of the soil that favor the vital activities of certain microbes, and interfere with the well-being of others of different habits; and the plants, in their turn, are presumably benefited by the activities of the microbes best adapted to the prescribed conditions. In the struggle for existence the dominance of these favored forms can not, however, be indefinitely maintained. The roots of one species of plant and their associated microbes, in appropriating their required supplies of nutritive materials, induce a metabolism of the soil that, sooner or later, renders it better fitted for other species of plants and other microbe associates; and these, in their turn, prepare the way for species of still different requirements in their processes of nutrition.

Soil metabolism, and the involved liberation or elaboration of plant food, will thus be promoted by a succession of plants of different habits of growth, each with its associated microbes; and the elements of fertility stored in, or permeating the soil, must, under such conditions, be more completely utilized.

It is practically misleading and inaccurate to say that leguminous plants appropriate the free nitrogen of the atmosphere. The evidence clearly shows that the soil-microbes which find favorable conditions for the exercise of their vital activities in the vicinity of, or in contact with, the roots of leguminous plants, are able to make use of the free nitrogen that permeates the soil, and that it is thus made available as combined nitrogen in the nutrition of the higher chlorophyl-bearing leguminous plants. The latest investigations are, therefore, strictly in accordance with the earlier experiments by Boussingault, and at Rothamsted, in showing that the soil is the source of the nitrogen of plants, and we must look to soil conditions as essential factors in determining the vital activities of the microbes that bring free nitrogen into the combined form that is available for the nutrition of the higher plants.

It must be admitted that red clover appropriates nitrogen that has been prepared for it from the free nitrogen of the soil through the agency of its symbiont microbes, but it is well known that it will not grow for many years in succession on the same land, and other crops must be introduced to put the soil in suitable condition for growing it again. The cereals with their different requirements, through their reactions upon the soil, which are undoubtedly aided by their associated microbes, and even the roots and companion microbes of other leguminous species, may have a direct influence in determining conditions of the soil that favor the nutritive processes of the clover roots and their specific symbiont microbes.

The interdependent biological relations of different farm-crops, and of the soil-microbes that find favorable nutritive conditions in the vicinity of their roots, appear to be quite as important factors in farm economy as the chemical composition of soils and crops, and the conditions of the soil that influence these relations are of great practical interest.

In the light of our present knowledge, it must be obvious that the applications of science to agriculture, so far as crop-growing is concerned, will be best promoted by investigations relating to the life history of these microbes, and their immediate and remote relations to the roots of plants of different species, and to processes of metabolism in the soil under different conditions.

The suggestion made by Dr. M. T. Masters, in his Plant Life on the Farm, that in the future the farmer may be able to apply the ferment-producing germs to his soil, to promote the growth of his crops, with greater advantage than he now derives from the application of chemical manures, seems to be fully warranted by the results of recent experiments; and it may be that the breeding of beneficial microbes may come to be of as great practical interest to the farmer as the breeding of yeast now is in the manufacture of beer.

We must not, however, be misled by the plausible inferences that may be made from the evidence presented in regard to this recently discovered source of nitrogen supply to leguminous plants under special conditions. It is not safe to assume that the nitrogen removed from the soil by crops and by drainage, or otherwise, is fully restored by corresponding amounts derived from free nitrogen through the agency of microbes, or that this is the sole or even the main source of the nitrogen of leguminous crops on average soils.

The Rothamsted experiments show that the previous accumulations of combined nitrogen in the soil must be the source of a large proportion of the nitrogen of leguminous crops, and that the frequent repetition of such crops does not prevent an appreciable diminution of the nitrogen of the surface soil.

The evidence we now have seems to indicate that, under ordinary conditions of farm practice, the microbes concerned in working up the accumulated stores of combined nitrogen in the soil are quite as significant factors in the nutrition of leguminous plants as their symbiont microbes that appropriate free nitrogen; and the conditions of soils and plants that determine the exercise of these diverse biological activities, in one direction or the other, present a promising field for future investigation. With every advance in knowledge there is increasing evidence that the transformations of matter and energy taking place in the normal processes of living organisms are so exceedingly complex that they can not be expressed or defined in simple formulæ relating to a single department of science, and this fact must be recognized if any real progress is made in solving the problems presented in the applications of science to agriculture.

THE ARYAN QUESTION AND PREHISTORIC MAN.

By Prof. T. H. HUXLEY.

II.

At the present time, four great separate bodies of water, the Black Sea, the Caspian, the Sea of Aral, and Lake Balkash, occupy the southern end of the vast plains which extend from the Arctic Sea to the highlands of the Balkan Peninsula, of Asia Minor, of Persia, of Afghanistan, and of the high plateaus of central Asia as far as the Altai. They lie for the most part between the parallels of 40° and 50° north, and are separated by wide stretches of barren and salt-laden wastes. The surface of Balkash is five hundred and fourteen feet, that of the Aral one hundred and fifty-eight feet above the Mediterranean; that of the Caspian eighty-five feet below it. The Black Sea is in free communication with the Mediterranean by the Bosporus and the Dardanelles; but the others, in historical times, have been at most temporarily connected with it and with one another, by relatively insignificant channels. This state of things, however, is comparatively modern. At no very distant period, the land of Asia Minor was continuous with that of Europe, across the present site of the Bosporus, forming a barrier several hundred feet high, which dammed up the waters of the Black Sea. A vast extent of eastern Europe and of western central Asia thus became a huge reservoir, the lowest part of the lip of which was probably situated somewhat more than two hundred feet above the sea-level, along the present southern water-shed of the Obi, which flows into the Arctic Ocean. Into this basin the largest rivers of Europe, such as the Danube and the Volga, and what were then great rivers of Asia, the Oxus and Jaxartes, with all the intermediate affluents, poured their waters. In addition, it received the overflow of Lake Balkash, then much larger; and, probably, that of the inland Sea of Mongolia. At that time the level of the Sea of Aral stood at least sixty feet higher than it does at present.* Instead of the separate Black, Caspian, and Aral Seas, there was one vast Ponto-Aralian Mediterranean, which must have been prolonged into arms and fiords along the lower valleys of the Danube, the Volga (in the course of which Caspian shells are now found as far as the Kuma), the Ural, and the other affluent rivers—while it seems to have sent its overflow northward through the present basin of the Obi. At the same time, there is reason to believe that the northern coast of Asia, which everywhere shows signs of recent slow upheaval, was situated far to the south of its present position. The consequences of this state of things have an extremely important bearing on the question under discussion. In the first place, an insular climate must be substituted for the present extremely continental climate of west central Eurasia. That is an important fact in many ways. For example, the present eastern climatal limitations of the beech could not have existed, and if primitive Aryan goes back thus far, the arguments based upon the occurrence of its name in some Aryan languages and not in others lose their force. In the second place, the European and the Asiatic moieties of the great Eurasiatic plains were cut off from one another by the Ponto-Aralian Mediterranean and its prolongations. In the third place, direct access to Asia Minor, to the Caucasus, to the Persian highlands, and to Afghanistan, from the European moiety was completely barred; while the tribes of eastern central Asia were equally shut out from Persia and from India by huge mountain ranges and table-lands. Thus, if the blond long-head race existed so far back as the epoch in which the Ponto-Aralian Mediterranean had its full extension, space for its development, under the most favorable conditions, and free from any serious intrusion of foreign elements from Asia, was presented in northern and eastern Europe.

When the slow erosion of the passage of the Dardanelles drained the Ponto-Aralian waters into the Mediterranean, they must have everywhere fallen as near the level of the latter as the make of the country permitted, remaining, at first, connected by such straits as that of which the traces yet persist between the Black and the Caspian, the Caspian and the Aral Seas respectively. Then, the gradual elevation of the land of northern Siberia, bringing in its train a continental climate, with its dry air and intense summer heats, the loss by evaporation soon exceeded the greatly

* This is proved by the old shore-marks on the hill of Kashkanatao in the midst of the delta of the Oxus. Some authorities put the ancient level very much higher—two hundred feet or more (Keane, Asia, p. 408).

reduced supply of water, and Balkash, Aral, and Caspian gradually shrank to their present dimensions. In the course of this process the broad plains between the separated inland seas, as soon as they were laid bare, threw open easy routes to the Caucasus and to Turkistan, which might well be utilized by the blond long-heads moving eastward through the plains contemporaneously left dry south and east of the Ural chain. The same process of desiccation, however, would render the route from east central Asia westward as easily practicable; and, in the end, the Aryan stock might easily be cut in two, as we now find it to be, by the movement of the Mongoloid brunet broad-heads to the west.

Thus we arrive at what is practically Latham's Sarmatian hypothesis—if the term "Sarmatian" is stretched a little, so as to include the higher parts and a good deal of the northern slopes of Europe between the Ural and the German Ocean; an immense area of country, at least as large as that now included between the Black Sea, the Atlantic, the Baltic, and the Mediterranean.

If we imagine the blond long-head race to have been spread over this area, while the primitive Aryan language was in course of formation, its northwestern and its southeastern tribes will have been fifteen hundred or more miles apart. Thus, there will have been ample scope for linguistic differentiation; and, as adjacent tribes were probably influenced by the same causes, it is reasonable to suppose that, at any given region of the periphery, the process of differentiation, whether brought about by internal or external agencies, will have been analogous. Hence, it is permissible to imagine that, even before primitive Aryan had attained its full development, the course of that development had become somewhat different in different localities; and, in this sense, it may be quite true that one uniform primitive Aryan language never existed. The nascent mode of speech may very early have got a twist, so to speak, toward Lithuanian, Slavonian, Teutonic, or Celtic in the north and west; toward Thracian and Greek in the southwest; toward Armenian in the south; toward Indo-Iranian in the southeast. With the centrifugal movements of the several fractions of the race, these tendencies of peripheral groups would naturally become more and more intensified in proportion to their isolation. No doubt, in the center and in other parts of the periphery of the Aryan region, other dialectic groups made their appearance; but whatever development they may have attained, these have failed to maintain themselves in the battle with the Finno-Tataric tribes, or with the stronger among their own kith and kin.*

Thus I think that the most plausible hypothetical answers

* See the views of J. Schmidt (stated and discussed in Schrader and Jevons, pp. 63–67), with which those here set forth are substantially identical.

which can be given to the two questions which we put at starting are these: There was and is an Aryan race—that is to say, the characteristic modes of speech, termed Aryan, were developed among the blond long-heads alone, however much some of them may have been modified by the importation of non-Aryan elements. As to the "home" of the Aryan race, it was in Europe, and lay chiefly east of the central highlands and west of the Ural. From this region it spread west, along the coasts of the North Sea to our islands, where, probably, it met the brunet long-heads; to France, where it found both these and the brunet short-heads; to Switzerland and south Germany, where it impinged on the brunet short-heads; to Italy, where brunet short-heads seem to have abounded in the north and long-heads in the south; and to the Balkan Peninsula, about the earliest inhabitants of which we know next to nothing. There are two ways to Asia Minor, the one over the Bosporus and the other through the passes of the Caucasus, and the Aryans may well have utilized both. Finally, the southeastern tribes probably spread themselves gradually over west Turkistan, and, after evolving the primitive Indo-Iranian dialect, eventually colonized Persia and Hindostan, where their speech developed into its final forms. On this hypothesis, the notion that the Celts and the Teutons migrated from about Pamir and the Hindoo Koosh is as far from the truth as the supposition that the Indo-Iranians migrated from Scandinavia. It supposes that the blond long-heads, in what may be called their nascent Aryan stage—that is, before their dialects had taken on the full Aryan characteristics—were spread over a wide region which is, conventionally, European; but which, from the point of view of the physical geographer, is rather to be regarded as a continuation of Asia. Moreover, it is quite possible, and even probable, that the blond long-heads may have arrived in Turkistan before their language had reached, or at any rate passed beyond, the stage of primitive Aryan; and that the whole process of differentiation into Indo-Iranian took place during the long ages of their residence in the basin of the Oxus. Thus, the question whether the seat of the primitive Aryans was in Europe, or in Asia, becomes very much a debate about geographical terminology.

The foregoing arguments in favor of Latham's "Sarmatian hypothesis" have been based upon data which lie within the ken of history, or may be surely concluded by reasoning backward from the present state of things. But, thanks to the investigation of the prehistoric archæologists and anthropologists during the last half-century, a vast mass of positive evidence respecting the distribution and the condition of mankind in the long interval between the dawn of history and the commencement of the recent epoch has been brought to light.

During this period, there is evidence that men existed in all those regions of Europe which have yet been properly examined; and such of their bony remains as have been discovered exhibit no less diversity of stature and cranial conformation than at present. There are tall and short men; long-skulled and broad-skulled men; and it is probably safe to conclude that the present contrast of blonds and brunets existed among them when they were in the flesh. Moreover, it has become clear that, everywhere, the oldest of these people were in the so-called neolithic stage of civilization. That is to say, they not merely used stone implements which were chipped into shape, but they also employed tools and weapons brought to an edge by grinding. At first they know little or nothing of the use of metals; they possess domestic animals and cultivated plants, and live in houses of simple construction.

In some parts of Europe little advance seems to have been made, even down to historical times. But in Britain, France, Scandinavia, Germany, western Russia, Switzerland, Austria, the plain of the Po, very probably also in the Balkan Peninsula, culture gradually advanced until a relatively high degree of civilization was attained. The initial impulse in this course of progress appears to have been given by the discovery that metal is a better material for tools and weapons than stone. In the early days of prehistoric archæology, Nilsson showed that, in the interments of the middle age, bronze largely took the place of stone, and that only in the latest was iron substituted for bronze. Thus arose the generalization of the occurrence of a regular succession of stages of culture, which were somewhat unfortunately denominated the "ages" of stone, bronze, and iron. For a long time after this order of succession in the same locality (which, it was sometimes forgotten, has nothing to do with chronological contemporaneity in different localities) was made out, the change from stone to bronze was ascribed to foreign, and, of course, Eastern, influences. There were the ubiquitous Phœnician traders and the immigrant Aryans from the Hindoo Koosh, ready to hand. But further investigation has proved * for various parts of Europe and made it probable for others, that though the old order of succession is correct it is incomplete, and that a copper stage must be interpolated between the neolithic and the bronze stages. Bronze is an artificial product, the formation of which implies a knowledge of copper; and it is certain that copper was, at a very early period, smelted out of the native ores, by the people of central Europe who used it. When they learned that the hardness and toughness of their metal were immensely improved by alloying it with a small quantity of

* "Proved" is perhaps too strong a word. But the evidence set forth by Dr. Much (Die Kupferzeit in Europa, 1886) in favor of a copper stage of culture among the inhabitants of the pile-dwellings is very weighty.

tin, they forsook copper for bronze and gradually attained a wonderful skill in bronze-work. Finally, some of the European people became acquainted with iron, and its superior qualities drove out bronze, as bronze had driven out stone, from use in the manufacture of implements and weapons of the best class. But the process of substitution of copper and bronze for stone was gradual, and, for common purposes, stone remained in use long after the introduction of metals.

The pile-dwellings of Switzerland have yielded an unbroken archæological record of these changes. Those of eastern Switzerland ceased to exist soon after the appearance of metals, but in those of the lakes of Neufchâtel and Bienne the history is continued through the stage of bronze to the beginning of that of iron. And in all this long series of remains, which lay bare the minutest details of the life of the pile-dwellers, from the neolithic to the perfected bronze stage, there is no indication of any disturbance such as must have been caused by foreign invasion; and such as was produced by intruders, shortly after the iron stage was reached. Undoubtedly the constructors of the pile-dwellings must have received foreign influences through the channel of trade, and may have received them by the slow immigration of other races. Their amber, their jade, and their tin show that they had commercial intercourse with somewhat distant regions. The amber, however, takes us no farther than the Baltic; and it is now known that jade is to be had within the boundaries of Europe, while tin lay no farther off than north Italy. An argument in favor of Oriental influence has been based upon the characters of certain of the cultivated plants and domesticated animals. But even that argument does not necessarily take us beyond the limits of southeastern Europe; and it needs reconsideration in view of the changes of physical geography and of climate to which I have drawn attention.

In connection with this question there is another important series of facts to be taken into consideration. When, in the seventeenth century, the Russians advanced beyond the Ural and began to occupy Siberia, they found that the majority of the natives used implements of stone and bone. Only a few possessed tools or weapons of iron, which had reached them by way of commerce; the Ostiaks and the Tatars of Tom, alone, extracted their iron from the ore. It was not until the invaders reached the Lena, in the far East, that they met with skillful smiths among the Jakuts,* who manufactured knives, axes, lances, battle-axes, and leather

* Andree, Die Metalle bei den Naturvölkern (p. 114). It is interesting to note that the Jakuts have always been pastoral nomads, formerly shepherds, now horse-breeders, and that they continue to work their iron in the primitive fashion; as the argument that metallurgic skill implies settled agricultural life not unfrequently makes its appearance.

jerkins studded with iron; and among the Tunguses and Lamuts, who had learned from the Jakuts.

But there is an older chapter of Siberian history which was closed in the seventeenth century, as that of the people of the pile-dwellings of Switzerland had ended when the Romans entered Helvetia. Multitudes of sepulchral tumuli, termed, like those of European Russia, "kurgans," are scattered over the north Asiatic plains, and are especially agglomerated about the upper waters of the Jenisei. Some are modern, while others, extremely ancient, are attributed to a *quasi*-mythical people, the Tschudes. These Tschudish kurgans abound in copper and gold articles of use and luxury, but contain neither bronze nor iron. The Tschudes procured their copper and their gold from the metalliferous rocks of the Ural and the Altai; and their old shafts, adits, and rubbish-heaps led the Russians to the rediscovery of the forgotten stores of wealth. The race to which the Tschudes belonged and the age of the works which testify to their former existence, are alike unknown. But seeing that a rumor of them appears to have reached Herodotus, while, on the other hand, the pile-dwelling civilization of Switzerland may perhaps come down as late as the fifth century B. C., the possibility that a knowledge of the technical value of copper may have traveled from Siberia westward must not be overlooked. If the idea of turning metals to account must needs be Asiatic, it may be north Asiatic just as well as south Asiatic. In the total absence of trustworthy chronological and anthropological data, speculation may run wild.

The oldest civilizations for which we have an, even approximately, accurate chronology are those of the valleys of the Nile and of the Euphrates. Here, culture seems to have attained a degree of perfection at least as high as that of the bronze stage, six thousand years ago. But before the intermediation of Etruscan, Phœnician, and Greek traders, there is no evidence that they exerted any serious influence upon Europe or northern Asia. As to the old civilization of Mesopotamia, what is to be said until something definite is known about the racial characters of its originators, the Accadians? As matters stand, they are just as likely to have been a group of the same race as the Egyptians or the Dravidians as anything else. And, considering that their culture developed in the extreme south of the Euphrates Valley, it is difficult to imagine that its influence could have spread to northern Eurasia except by the Phœnician (and Carian?) intermediation which was undoubtedly operative in comparatively late times.

Are we then to bring down the discovery of the use of copper in Switzerland to, at earliest, 1500 B. C., and to put it down to Phœnician hints? But why copper? At that time the Phœnicians must have been familiar with the use of bronze. And if, on the other hand, the northern Eurasiatics had got as far as copper, by the help of their own ingenuity, why deny them the capacity to make the further step to bronze? Carry back the borrowing system as far as we may, in the end we must needs come to some man or men from whom the novel idea started, and who after many trials and errors gave it practical shape. And there really is no ground in the nature of things for supposing that such men of practical genius may not have turned up, independently in more races than one.

The capacity of the population of Europe for independent progress while in the copper and early bronze stage—the "palæo-metallic" stage, as it might be called—appears to me to be demonstrated in a remarkable manner by the remains of their architecture. From the crannog to the elaborate pile-dwelling, and from the rudest inclosure to the complex fortification of the terramare, there is an advance which is obviously a native product. So with the sepulchral constructions; the stone cist, with or without a preservative or memorial cairn, grows into the chambered graves lodged in tumuli; into such megalithic edifices as the dromic vaults of Maes How and New Grange; to culminate in the finished masonry of the tombs of Mycenæ, constructed on exactly the same plan. Can any one look at the varied series of forms which lie between the primitive five or six flat stones fitted together into a mere box, and such a building as Maes How, and yet imagine that the latter is the result of foreign tuition? But the men who built Maes How, without metal tools, could certainly have built the so-called "treasure-house" of Mycenæ with them.

If these old men of the sea, the heights of Hindoo-Koosh-Pamir and the plain of Shinar, had been less firmly seated upon the shoulders of anthropologists, I think they would long since have seen that it is at least possible that the early civilization of Europe is of indigenous growth; and that, so far as the evidence at present accumulated goes, the neolithic culture may have attained its full development, copper may have gradually come into use, and bronze may have succeeded copper, without foreign intervention.

So far as I am aware, every raw material employed in Europe up to the palæo-metallic stage is to be found within the limits of Europe; and there is no proof that the old races of domesticated animals and plants could not have been developed within these limits. If any one chose to maintain that the use of bronze in Europe originated among the inhabitants of Etruria and radiated thence along the already established lines of traffic to all parts of Europe, I do not see that his contention could be upset. It would be hard to prove either that the primitive Etruscans could not have discovered the way to manufacture bronze, or that they did not discover it and become a great mercantile people in consequence, before Phœnician commerce had reached the remote shores of the Tyrrhene Sea.

Can it be safely concluded that the palæo-metallic culture which we have been considering was the appanage of any one of the western Eurasiatic races rather than another? Did it arise and develop among the brunet or the blond long-heads or among the brunet short-heads? I do not think there are any means of answering these questions, positively, at present. Schrader has pointed out that the state of culture of the primitive Aryans, deduced from philological data, closely corresponds with that which obtained among the pile-dwellers in the neolithic stage. But the resemblance of the early stages of civilization among the most different and widely separated races of mankind should warn us that archæology is no more a sure guide in questions of race than philology.

With respect to the osteological characters of the people of the Swiss pile-dwellings information is as yet scanty. So far as the present evidence goes, they appear to have comprised both broad-heads and long-heads of moderate stature.* In France, England, and Germany, both long and broad skulls are found in tumuli belonging to the neolithic stage. In some parts of England the long skulls, and in others the broad skulls, accompany the higher stature. In the Scandinavian Peninsula, nine tenths of the neolithic people are decided long-heads; in Denmark there is a much larger proportion of broad-heads.

In view of all the facts known to me (which can not be stated in greater detail in this place), I am disposed to think that the blond long-heads, the brunet long-heads, and the brunet broad-heads have existed on the continent of Europe throughout the Recent period; that only the former two at first inhabited our islands; but that a mixed race of tall broad-heads, like some of the Black-Foresters of the present day, so excellently described by Ecker, migrated from the continent and formed that tall contingent of the population which has been identified (rightly or wrongly) with the Belgæ by Thurnam, and which seems to have subsequently lost itself among the predominant brunet and blond long-heads.

I do not think there is anything to warrant the conclusion that the palæo-metallic culture of Europe took its origin among the

* Prof. Virchow has guardedly expressed the opinion that the oldest inhabitants of the Swiss pile-dwellings were broad-heads, and that later on (commencing before the bronze stage) there was a gradual infusion of long-heads among them. (Zeitschrift für Ethnologie, xvii, 1885.) There is independent evidence of the existence of broad-heads in the Cevennes during the neolithic period, and I should be disposed to think that this opinion may well be correct; but the examination of the evidence on which it is, at present, based does not lead me to feel very confident about it.

blond long-head (or supposed Aryan) race; or that the people of the Swiss pile-dwellings belonged to that race. The long-heads among them may just as likely have been brunets. In northeastern Italy there is clear evidence of the superposition of at least four stages of culture, in which that of the copper and bronze using terramare people comes second; a stage marked by Etruscan domination occupies the third place; and that is followed by the stage which appertains to the Gauls, with their long swords and other characteristic iron-work. In western Switzerland, on the other hand, at La Téne, and elsewhere, similar relics show that the Gauls followed upon the latest population of the pile-dwellings among whom traces of Etruscan influence (though not of dominion) are to be found. Helbig supposes the terramare people to have been Greco-Latin-speaking Pelasgi, and consequently Aryan. But we can not suppose the people of the pile-dwellings of Switzerland to have been speakers of primitive Greco-Latin (if ever there was such a language). And if the Gauls were the first speakers of Celtic who got into Switzerland, what Aryan language can the people of the pile-dwellings have spoken? *

As I have already mentioned, there is not the least doubt that man existed in northwestern Europe during the Pleistocene or Quaternary epoch. It is not only certain that men were contemporaries of the mammoth, the hairy rhinoceros, the reindeer, the cave bear, and other great carnivora, in England and in France, but a great deal has been ascertained about the modes of life of our predecessors. They were savage hunters, who took advantage of such natural shelters as overhanging rocks and caves, and perhaps built themselves rough wigwams; but who had no domestic animals, and have left no sign that they cultivated plants. In many localities there is evidence that a very considerable interval—the so-called *hiatus*—intervened between the time when the Quaternary or palæolithic men occupied particular caves and river basins and the accumulation of the *débris* left by their neolithic successors. And, in spite of all the warnings against negative evidence afforded by the history of geology, some have very positively asserted that this means a complete break between the Quaternary and the Recent populations—that the Quaternary population followed the retreating ice northward and left behind them a desert which remained unpeopled for ages. Other high authorities, on the contrary, maintain that the races of men who now inhabit Europe may all be traced back to the

* See Dr. Munro's excellent work, The Lake Dwellings of Europe, for La Téne. Readers of Prof. Rhys's recent articles (Scottish Review, 1890) may suggest that the pile-dwelling people spoke the Gaedhelic form of Celtic, and the Gauls the Brythonic form.

great Ice age. When a conflict of opinion of this kind obtains among reasonable and instructed men, it is generally a safe conclusion that the evidence for neither view is worth much. Certainly that is the result of my own cogitations with regard to both the hiatus doctrine (in its extreme form) and its opposite—though I think the latter by much the more likely to turn out right. But I hesitate to adopt it on the evidence which has been obtained up to this time.

No doubt, human bones and skulls of various types have been discovered in close proximity to palæolithic implements and to skeletons of Quaternary quadrupeds; no doubt, if the bones and skulls in question were not human, their contemporaneity would hardly have been questioned. But, since they are human, the demand for further evidence really need not be ascribed to mere conservative prejudice. Because the human biped differs from all other bipeds and quadrupeds, in the tendency to put his dead out of sight in various ways; commonly by burial. It is a habit worthy of all respect in itself, but generative of subtle traps and grievous pitfalls for the unwary investigator of human paleontology. For it may easily happen that the bones of him that "died o' Wednesday" may thus come to lie alongside the bones of animals that were extinct thousands of years before that Wednesday; and yet the interment may have been effected so many thousands of years ago that no outward sign betrays the difference in date. In all investigations of this kind, the most careful and critical study of the circumstances is needful if the results are to be accepted as perfectly trustworthy.

In the case of the remains found in a cave of the valley of the Neander, near Düsseldorf, half a century ago—the characters of which gave rise to a vast amount of discussion at that time and subsequently–the circumstances of the discovery were but vaguely known. The skeleton was met with in a deposit, the loess, which is known to be of Quaternary age; there was no evidence to show how it came there. Consequently, not only was its exact age justly and properly declared to be a matter of doubt; but those who, on scientific or other grounds, were inclined to minimize its importance could put forth plausible speculations about its nature which do not look so well under the light thrown by a more advanced science of anthropology. It could be and it was suggested that the Neanderthal skeleton was that of a strayed idiot; that the characters of the skull were the result of early synostosis or of late gout; and, in fact, any stick was good enough to beat the dog withal.

As some writings of mine on the subject led to my occupation of a prominent position among the belabored dogs of that day, I have taken a mild interest in watching the gradual rehabilitation of my old friend of the Neanderthal among normal men, which has been going on of late years. It has come to be generally admitted that his remarkable cranium is no more than a strongly marked example of a type which occurs, not only among other prehistoric men, but is met with, sporadically, among the moderns; and that, after all, I was not so wrong as I ought to have been, when I indicated such points of similarity among the skulls found in our river-beds and among the native races of Australia.* However, doubts still clung about the geological age of the various deposits in which skulls of the Neanderthal type were subsequently found; and it was not until the year 1886 that two highly competent observers, Messrs. Fraipont and Lohest, the one an anatomist, the other a geologist, furnished us with evidence such as will bear severe criticism. At the mouth of a cave in the commune of Spy, in the Belgian province of Namur, Messrs. Fraipont and Lohest discovered two skeletons of the Neanderthal type; and the elaborate account of their investigations which they have published appears to me to leave little room for doubt that the men of Spy fabricated the palæolithic implements, and were the contemporaries of the characteristic Quaternary quadrupeds, found with them. The anatomical characters of the skeletons bear out conclusions which are not flattering to the appearance of the owners. They were short of stature but powerfully built, with strong, curiously curved thigh-bones, the lower ends of which are so fashioned that they must have walked with a bend at the knees. Their long, depressed skulls had very strong brow-ridges; their lower jaws, of brutal depth and solidity, sloped away from the teeth downward and backward, in consequence of the absence of that especially characteristic feature of the higher type of man, the chin prominence. Thus these skulls are not only eminently "Neanderthaloid," but they supply the proof that the parts wanting in the original specimen harmonized in lowness of type with the rest.

After a very full discussion of the anatomical characters of these skulls, M. Fraipont says:

> To sum up, we consider ourselves to be in a position to say that, having regard merely to the anatomical structure of the man of Spy, he possessed a greater number of pithecoid characters than any other race of mankind.‡

And, after enumerating these, he continues:

> The other and much more numerous characters of the skull, of the trunk, and of the limbs seem to be all human. Between the man of Spy and an existing anthropoid ape there lies an abyss.

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* Evidence as to Man's Place in Nature, 1863, p. 155.

† Fraipont et Lohest, La Race humaine de Néanderthal, ou de Canstatt, en Belgique. Archives de Biologie, 1886.

Now, that is pleasant reading for me, because, in 1863, I committed myself to the assertion that the Neanderthal skull was "the most pithecoid of human crania yet discovered," yet that "in no sense can the Neanderthal bones be regarded as the remains of a human being intermediate between men and apes,"* and that "the fossil remains of man hitherto discovered do not seem to me to take us appreciably nearer to that lower pithecoid form, by the modification of which he has, probably, become what he is."†

As the evidence stood seven and twenty years ago, in fact, it would have been imprudent to assume that the Neanderthal skull was anything but a case of sporadic reversion. But, in my anxiety not to overstate my case, I understated it. The Neanderthaloid race is "appreciably nearer," though the approximation is but slight. In the words of M. Fraipont:

> The distance which separates the man of Spy from the modern anthropoid ape is undoubtedly enormous; between the man of Spy and the *Dryopithecus* it is a little less. But we must be permitted to point out that, if the man of the later Quaternary age is the stock whence existing races have sprung, he has traveled a very great way.
>
> From the data now obtained, it is permissible to believe that we shall be able to pursue the ancestral type of men and the anthropoid apes still further, perhaps as far as the Eocene and even beyond.‡

These conclusions hold good, whatever the age of the men of Spy; but they possess a peculiar interest if we admit, as I think on the evidence must be admitted, that these human fossils are of Pleistocene age. For, after all due limitations, they give us some, however dim, insight into the rate of evolution of the human species, and indicate that it has not taken place at a much faster or slower pace than that of other mammalia. And, if that is so, we are warranted in the supposition that the genus *homo*, if not the species which the courtesy or the irony of naturalists has dubbed *sapiens*, was represented in Pliocene, or even in Miocene times. But I do not know by what osteological peculiarities it could be determined whether the Pliocene or Miocene man was sufficiently sapient to speak or not;# and whether, or not, he answered to the

* Man's Place in Nature, pp. 156, 157.

† Ibid., p. 159.

‡ "Where, then, must we look for primeval man? Was the oldest *Homo sapiens* Pliocene or Miocene, or yet more ancient? In still older strata do the fossilized bones of an ape more anthropoid or a man more pithecoid than any yet known await the researches of some unborn paleontologist?"—(Man's Place in Nature, p. 159.)

I am perplexed by the importance attached by some to the presence or absence of the so-called "genial" elevations. Does any one suppose that the existence of the genio-hyo-glossus muscle, which plays so large a part in the movements of the tongue, depends on that of these elevations?

definition "rational animal" in any higher sense than a dog or an ape does.

There is no reason to suppose that the genus *homo* was confined to Europe in the Pleistocene age; it is much more probable that this, like other mammalian genera of that period, was spread over a large extent of the surface of the globe. At that time, in fact, the climate of regions nearer the equator must have been far more favorable to the human species; and it is possible that, under such conditions, it may have attained a higher development than in the north. As to where the genus *homo* originated, it is impossible to form even a probable guess. During the Miocene epoch, one region of the present temperate zones would serve as well as another. The elder Agassiz long ago tried to prove that the well-marked areas of geographical distribution of mammals have their special kinds of men; and, though this doctrine can not be made good to the extent which Agassiz maintained, yet the limitation of the Australian type to New Holland, the approximate restriction of the negro type to ultra-Saharal Africa, and the peculiar character of the population of Central and South America, are facts which bear strongly in favor of the conclusion that the causes which have influenced the distribution of mammals in general have powerfully affected that of man.

Let it be supposed that the human remains from the caves of the Neanderthal and of Spy represent the race, or one of the races, of men who inhabited Europe in the Quaternary epoch, can any connection be traced between it and existing races? That is to say, do any of them exhibit characters approximating those of the Spy men or other examples of the Neanderthaloid race? Put in the latter form, I think that the question may be safely answered in the affirmative. Skulls do occasionally approach the Neanderthaloid type, among both the brunet and the blond long-head races. For the former, I pointed out the resemblance, long ago, in some of the Irish river-bed skulls. For the latter, evidence of various kinds may be adduced; but I prefer to cite the authority of one of the most accomplished and cautious of living anthropologists. Prof. Virchow was led, by historical considerations, to think that the Teutonic type, if it still remained pure and undefiled anywhere, should be discoverable among the Frisians, in their ancient island home on the north German coast, remote from the great movement of nations. In their tall stature and blond complexion the Frisians fulfilled expectation, but their skulls differed in some respects from those of the neighboring blond long-heads. The depression, or flattening (accompanied by a slight increase in breadth), which occurs occasionally among the latter, is regular and characteristic among the Frisians; and in other respects, the Frisian skull unmistakably approaches the Neanderthal and Spy type.* The fact that this resemblance exists is of none the less importance because the proper interpretation of it is not yet clear. It may be taken to be a pretty sure indication of the physiological continuity of the blond long-heads with the Pleistocene Neanderthaloid men. But this continuity may have been brought about in two ways. The blond long-heads may exhibit one of the lines of evolution of the men of the Neanderthaloid type. Or, the Frisians may be the result of the admixture of the blond long-heads with Neanderthaloid men, whose remains have been found at Canstatt and at Gibraltar, as well as at Spy and in the valley of the Neander; and who therefore seem, at one time, to have occupied a considerable area in western Europe. The same alternatives present themselves when Neanderthaloid characters appear in skulls of other races. If these characters belong to a stage in the development of the human species, antecedent to the differentiation of any of the existing races, we may expect to find them in the lowest of these races, all over the world, and in the early stages of all races. I have already referred to the remarkable similarity of the skulls of certain tribes of native Australians to the Neanderthal skull; and I may add that the wide differences in height between the skulls of different tribes of Australians afford a parallel to the differences in altitude between the skulls of the men of Spy and those of the grave-rows of north Germany. Neanderthaloid features are to be met with, not only in ancient long skulls; those of the ancient broad-headed people entombed at Borreby in Denmark have been often noted.

Reckoned by centuries, the remoteness of the Quaternary or Pleistocene age from our own is immense, and it is difficult to form an adequate notion of its duration. Undoubtedly there is an abysmal difference between the Neanderthaloid race and the comely living specimens of the blond long-heads with whom we are familiar, But the abyss of time between the period at which north Europe was first covered with ice, when savages pursued mammoths and scratched their portraits with sharp stones in central France, and the present day, ever widens as we learn more about the events which bridge it. And, if the differences between the Neanderthaloid men and ourselves could be divided into as many parts as that time contains centuries, the progress from part to part would probably be almost imperceptible.—*Nineteenth Century.*

[*Concluded.*]

* Virchow, Beiträge zur physischen Anthropologie der Deutschen (Abh. der Königlichen Akademie der Wissenschaften zu Berlin, 1876). See particularly p. 238 for the full recognition of the Neanderthaloid characters of Frisian skulls and of the ethnological significance of the similarity.

THE STORAGE OF COLD.

By CHARLES MORRIS.

THERE are two processes constantly active upon the surface of the earth which are of the utmost importance as regards its suitability for human habitation—the storage of heat and the storage of cold. Of these we are here concerned only with the latter. The source and method of the storage of cold (a negative process, which we may here treat as a positive) are much less evident and not so generally known as those of heat-storage, and a review of them may be of interest.

The source of the stored cold is the upper atmosphere, and the principal storing substance snow. Here we are on ground familiar only to scientists. Readers generally are not aware of the vitally important part which snow plays in the economy of nature. The lightly falling snow-flake, with its poetic affiliation and its attractive aspects, has its aspect of terror as well, for the feathery snow has done more to limit man's dominion of the earth than any other of the unfriendly agencies of Nature, even if we count the fiery ravage of the volcano and the ruinous work of the earthquake. While the rains are friends to man, and efficient agents in the progress of civilization, the snows are his enemies, and the most persistently hostile of his foes.

It need scarcely be said that the invigorating beams of the sun visit the earth in very differing measure, varying from tropical profusion to frigid sparseness. This diversity of heat distribution is partly overcome by the agency of the winds and waters, particularly the latter, since the great ocean currents carry vast supplies of heat from the torrid zone toward the poles, and drive far backward the boundaries of the realm of frost. The agency of the air in this heat convection is of less importance. The anti-trade winds move through the upper atmosphere, and lose their heat before descending to the earth; but surface winds from the tropics convey a considerable share of the torrid heats to the colder zones.

Snow is the great opponent to the full effect of this distributed heat. It constitutes an agent of Nature by which the chill of the upper atmosphere is conveyed to the earth's surface, and stored there in a more or less persistent form, which requires much of the solar heat and the warmth of tropic winds and waters to overcome. If it be asked how snow can produce such an effect, we must advert to the heat relations of water. A large supply of insensible heat—latent heat, as it is called—exists in liquid and gaseous matter. In the freezing process this heat becomes sensible, and is absorbed by the surrounding substances. Such a process takes place on a large scale in the chilled fields of the upper air, the water vapor of the atmosphere being condensed into snow and its latent heat lost to the surrounding frosty air. In a word, snow is water which has lost its latent heat, or—in a negative sense—has absorbed cold from the upper atmosphere. The falling snow conveys this chill to the earth, and thus acts as a great refrigerating agent. To overcome the cold thus conveyed from mid-air to the earth heat is necessary, and large supplies, which might have been usefully employed in the service of man, are lost in the conversion of vapor into snow, and thus indirectly consumed in warming the upper air.

It may be said here that the conversion of vapor into rain is also exhaustive of latent heat. In the evaporation of the oceanic waters a very considerable quantity of heat is absorbed, and conveyed to the upper air as the latent heat of water vapor. Of this heat a part is lost in the formation of rain, and a larger part in the formation of snow. But the rain reaches the earth in a condition suitable for service. It does not, like the snow, need to be changed in its physical state, at a great expense in heat, to render it serviceable. In fact, the chilling influence of rain is inconsiderable, the heat-consuming agency of snow great and important, and the mode in which its work is performed calls for some consideration.

Snow has several curious methods of extending the sphere of its hostile influence. The comparatively light snows which fall in our latitude are of minor importance, since they readily yield to the early spring sunbeams. They are in some degree beneficial to the fertile surface and protective to its more tender annual plants, while their only important adverse effect is the dangerous flooding of the rivers, due to their rapid melting. But the deep and persistent snows of northern regions are far more exhaustive of solar heat, and reduce the agricultural season of those regions to a dangerously short period. In their melting, also, the surface air is chilled, and winds from the north convey this chilled air far to the south, thus spreading widely over the warmer zones the frost-inducing influence of the melting snows.

We have seen how the tropic heats are carried toward the poles by winds and waters. The frigid cold is carried toward the tropics by the same agencies—chilled winds and cold ocean currents. It is carried by another agent of great importance, the direct creep of the snow itself toward the lower latitudes. This agency has once—perhaps many times—produced an extraordinary effect upon the surface of the earth, one far surpassing that of volcanic explosions and lava outflows in its adverse influence. At present this glacial action is greatly reduced, but is still of much importance. Were it not for the snow-fall the problem of climate would be materially modified, and the temperature of the earth's surface much ameliorated. The seasons would gain a regularity which they do not now possess, the agricultural period of the colder zones be much extended, and the domain of agriculture be considerably widened, by the recovery of broad regions which are now covered during much or all of the agricultural season by snow.

In the winter the frost-laden strata of the atmosphere descend to the surface over much of the globe, and produce a direct refrigerating influence upon the surface soil and waters. This winter freezing, however, is of minor importance, as it, except in the polar regions, quickly yields to the spring suns, while its influence upon the summer temperature of lower latitudes is but slight. Only for the snow-fall this would be our sole source of cold. But the vast blanket of snow which descends annually upon the colder zones conveys downward the severe chill of higher layers of the air, borrowing from a mighty storehouse of cold which broadly impends above the earth. This snow blanket must be removed, and its stored cold overcome by solar heat, before agriculture can begin, and in this process weeks or months pass away, the effect being greatly to reduce the area of the earth's surface which is suitable for human habitation.

The snow of the frigid zones does not wait for the sun to reach it. It travels toward the tropics to meet the sun. This creep of the snow, as we may call it, takes the forms of the glacier and the iceberg. It also acts in another curious method, not generally known, but which is described by Nordenskiöld, in his Voyage of the Vega. Speaking of the natural conditions at a winter station near Bering Strait, he says: "The fall of snow was not great, but, as there was in the course of the winter no thaw of such continuance that the snow was at any time covered with a coherent melted crust, a considerable portion of the snow that fell remained so loose that with the least puff of wind it was whirled backward and forward. . . . Even when the wind was slight and the sky clear, there ran a stream of snow some centimetres in height along the ground in the direction of the wind, and thus principally from northwest to southeast. . . . The quantity of water which in a frozen form is thus removed in this certainly not deep but uninterrupted and rapid current, over the north coast of Siberia to more southerly regions, must be equal to the mass of water in the giant rivers of our globe, and plays a sufficiently great *rôle* among others as a carrier of cold to the most northerly forest regions to receive the attention of meteorologists." It may be that a similar condition prevails over northern America, though concerning this we have no evidence at hand. The wind thus seems to play a double *rôle* in conveying cold southward—one through the direct carriage of the snow, the other through the aërial chill caused by the melting snow.

The leading agent in the southward creep of the snow, however, is the glacier, and its offspring, the iceberg. The glacier is due to an important relation of the snows to the solar rays; namely, to that in which the stored cold is too great in quantity for the whole year's supply of heat to overcome, so that a part of each year's snow-fall is carried over to the next. There can be no glacier where the whole of the snow-fall is melted, even if the heat of the whole season is occupied in melting it; but, wherever a portion of the snow-supply is carried over from winter to winter, glacial action is inevitable. In every such case the snows must steadily accumulate, their thickness increasing year by year. The growing pressure converts the under portions of this snow mass into ice, and this, through its normal plasticity, is forced by the weight upon it toward lower levels or more southerly regions, until it reaches its limit at that point in which the melting power of the sun balances the growth of the glacier.

The localities of glacial action are, therefore, the peaks and valleys of lofty mountains and the elevated regions of the frigid zones, or the lower regions of the latter in localities of abundant snow-fall. In all such places the heat derived from the sun is insufficient to melt the snow, which, therefore, necessarily creeps to warmer regions in the form of glacial ice. The principal seats of glacier formation in the north frigid zone are Greenland and Alaska. The remaining surface of northern America and that of Siberia are too low in elevation, and perhaps too light in snow-fall, to permit any important glacial effect. Of the northern glacier-forming localities, Greenland is much the most important, and its refrigerating influence upon the coast lands of Europe and America is considerable. The mountains of snow which are heaped upon its elevated regions send down huge glaciers to the coast, which not only aid to chill the waters of the southward-flowing currents, but send south an annual fleet of icebergs, borne upon these cold currents, and making their way far into the Gulf-Stream domain of the Atlantic. No small quantity of the heat-supply of this warm current is exhausted in melting the floating mountains of ice. This heat is lost to the northern continents, and their temperature reduced in consequence, possibly much more than we imagine. There is thus an annual battle between the earth's stores of heat and cold. The former, in the condition of warm ocean currents, makes its way far north. The latter, brought down from mid-air by the snows, and locked up in the glaciers, and their offspring—the icebergs—makes its way far south. They meet in mid-ocean, where an active conflict takes place. The heat conquers, but at a great loss of its valuable supplies, and a consequent refrigeration of the adjacent waters, air, and land.

In the southern seas this effect of the snow-fall is much more considerable. A belt of glacier-forming lands surrounds the south pole, and the annual iceberg fleet is much larger than that of the north. The air indraught to the north polar region is estimated to extend over a disk of fifty-five hundred miles diameter; that to the south polar region over a disk of seven thousand miles diameter. The former is largely composed of land surface; the latter is nearly all water, and its air is therefore much more charged with moisture. In consequence, the moist air which reaches the south frigid zone is greatly in excess of that which reaches the northern zone of cold, and the snow-fall there must be very much more considerable. It is estimated that the south polar ice-cap can not be less than three miles and may be twelve miles in height. The thrust of this vast ice mountain upon the viscid material beneath it is necessarily enormous, and a lofty ice-cliff is pushed off the land at a rate of not less than a quarter of a mile annually, and this around a circle of great extent. Fortunately, the immense fleet of huge icebergs, thus annually launched, has no continental land to act upon, its refrigerating influence being mainly exercised upon stretches of ocean out of the ordinary channels of navigation, and far removed from the important seats of human habitation.

There was a time, far in the past, but within the era of man's occupancy of the earth, when the influence of the snow was enormously greater than at present, and when the atmospheric chill, stored in the falling flakes, rendered a vast region of the northern continents unfit for human habitation, and extended the border of the frozen zone far toward the present limits of tropical heat. Doubtless if at present all the snow which forms in the upper air should reach the earth's surface, a glacial epoch would now exist in the north temperate zone. The experience of balloonists and of mountain-climbers teaches us that snow forms and falls in all seasons of the year. This is melted by the warmed lower strata of air, and the earth thus saved from its chilling influence. The solar heat, which has already done good work for man upon the surface, performs new and useful labor for him in the atmosphere, by melting this falling snow, so that its water reaches the earth only in the form of rain.

At the period mentioned the snow limit in the atmosphere was much lower than at present, and the great bulk of the snow-fall reached the surface unmelted. As a result, the region of an annual snow surplus extended much farther south than at present, covering much and perhaps all of British America, and a broad zone of northern Europe. It is not necessary to dwell upon its re-results. They have already been abundantly told. It will suffice to say, briefly, that the glacial ice thus formed, accumulating until it became of mountain height, crept steadily southward, combating with the sun as it went, until the front of the polar line of battle reached a limit extending across central Pennsylvania, and westward to the Rocky Mountain slope. In Europe it covered many of the active seats of modern civilization. Along this extended line conditions existed resembling those now found along the coast-line of Greenland. At this line the arrows of the sun checked the hosts of the snow, the annual heat balancing the yearly supply of cold, while great streams of chilled water poured from the melting ice. The mountain ranges farther south also sent out their glaciers over wide regions, and a vast extent of the now habitable earth was held prisoner by the snow.

To what extent the remaining regions of the continents were chilled by these vast glaciers can not be easily determined. The cold winds blowing south must have interfered seriously with vegetation over a broad zone. And the oceans of those days must have been crowded with icebergs to an extent far surpassing the commercial fleets of modern times. These may have floated to the tropic seas, and gone far toward exhausting the heat of the torrid zone, and chilling at their source the great ocean currents.

A time at length came when victory perched upon the banners of the sun. Step by step the cohorts of the snow retreated. The earth slowly reappeared from under its crushing weight of ice. Northward went the ice front, as the solar power increased, until it reached the arctic seas, and the northern continents were released from the foe which had so long held them in captivity. But the surface of the continents emerged in a greatly changed aspect. Great masses of rock had been torn by the gliding ice from the mountains, carried far southward, and deposited in a mighty breastwork of rounded and polished stones. The mountains themselves had been scratched and polished by rigid tools of stone, frozen into the ice. Large quantities of gravel and fine mud had been formed by the grinding of the rocks, and carried south by the flowing waters, to be deposited as hills of gravel and beds of clay many miles away from the glacial front. Enormous labor had been done in scooping out the earth's surface into hollows and basins, which became filled with water from the melting ice, and formed the host of lakes, large and small, which now exist over much of the formerly ice-covered region.

Such were some of the permanent effects of this long dominion of the snow, in its secondary form of glacial ice. Undoubtedly the growth of human culture was greatly interfered with by the long-continued inhospitable condition thus produced, and it is quite possible that, but for the glacial period, the civilization of mankind would have been much further advanced than at present, and most of the awkward questions which are troubling us now would have been settled ages ago. They might, however, have been succeeded by other questions quite as awkward, for the solving of perplexing problems of social relations seems part of the destiny of man. It has been suggested that the glacial age may have aided human advancement, by forcing primitive man to adopt new methods of shelter, clothing, and food-getting, in self-defense against the cold. Thus, instead of hindering it may have helped to break the reign of savagery.

Here it may be well to advert to another probable refrigerating agency of snow to which no attention has hitherto been paid. Aërial snow—snow that forms in the upper strata and is melted at lower levels of the air—may have always been an important agent in the cooling of the earth, aiding essentially in the upward transport of heat during the ages when the surface was at a high temperature. In those ages the great quantity of water vapor in the air hindered the free radiation of heat, whose conveyance upward was mainly accomplished by warm ascending currents. This may have been greatly aided by the conversion of the vapor of these vertical winds into snow in the upper air, the descent of this snow, and the exhaustion of much of the lower heat in melting it.

Such a state of affairs may have extended much further back in time than would at first thought be deemed possible; perhaps to that period when the earth was still too hot to permit the existence of liquid water, and the substance of the present oceans was held in the air as water vapor. Even then the rarer regions of the atmosphere were probably chilled below the temperature of congelation, and a snow limit existed, though very much higher than at present. The range of vapor must also have extended much higher than at present, possibly far within the region of congelation. Therefore, at the period when the surface heat prevented the existence of liquid water, there may have been a continuous formation and fall of snow in the upper strata of the atmosphere. The melting of this snow at lower levels, and the vaporizing, at still lower levels, of the rain which it yielded, must have been highly important agents in the upward transit of the surface heat.

There is thus much reason to believe that the snow-fall, which within the recent period has played so prominent a part in terrestrial affairs, has been from a very early era an active agent in the cooling of the earth, the snow limit of the atmosphere gradually descending through the ages until, in the glacial era, it nearly approached the surface, and vastly extended the ocean domain by covering a broad region of the land surface with frozen water of almost oceanic depth. With this must have been associated a marked lowering of the level of the oceans, though to what extent it would not be safe to estimate.

COEDUCATION IN SWISS UNIVERSITIES.

By FLORA BRIDGES.

THERE is a sturdy freedom in the Swiss character which is admirable in American eyes, and which seems to make the people grow naturally and easily into conditions closely approaching our own ideals. The soil is not so deep, to be sure, nor so rich, as it might be but for circumstances which the Swiss himself already sees and is taking measures to modify. It is interesting to note the progress of thought in Switzerland in the development of schools. Before the government was thoroughly organized, there were all sorts of schools, loosely, if at all, connected with each other. Each canton, or state, had its own schools, however, thus forming a center of growth whose development may fairly illustrate that in every other state. Let us take Zurich. Here the principal school was one founded and cared for chiefly for the purpose of educating men for the ministry of the Church, in which, however, provision was also made for the study of the classics by those who had chosen some other life-work. This was the beginning of systemization; for this school rested upon those of lower grade, and was itself subordinate to a kind of council made up of its teachers, the leaders of the Church in Zurich, and four other men, churchmen or laymen. These latter were to be elected every year, with privilege of re-election, by a higher Educational Council, two from its own number, the other two at large. This council was composed of the burgomaster, two representatives of state, and twelve other men, eight of whom were appointed by the state Senate.

This condition of schools—there were in addition two for technical training—lasted until 1831, in the spring of which year a new state Constitution was drafted. This gave all authority in school matters to the Educational Council, which it reorganized in the autumn of the same year. It was to consist of fifteen members, appointed by the Senate. Three of these should be chosen from the legislative body of the state, half of the others with reference to their knowledge of and interest in the higher schools, the remainder with reference to the lower schools and practical pedagogics. This new council, under the conviction that it was desirable to obtain closer connection between the higher schools, at once established two important institutions. The old gymnasium—the Carolinum, as that theologico-classical school had been named after Charlemagne—was enlarged and developed in two directions, scientific and literary on the one hand, and industrial on the other. A still higher school was organized with theological, law, medical, and philosophical departments, which was at first modestly called a *Facultäts-Anstalt*—an institution for higher study. This latter school became in 1833 the University of Zurich, founded by the state "that all her citizens might develop themselves freely, according to nature, in science and art. . . . Its purpose is partly to increase the sum of knowledge, partly to further the interests of Church and state through higher scientific culture of professions." So the university was organized, the canton school by its side as a helper, both under care of the state through the Educational Council, whose president is one of the governor's staff. In similar manner the Polytechnicum—the national school—is under the care of the General Government. The professors in the university are appointed by the Educational Council, and an educational synod, once a year or oftener, if especial need arises, gives opportunity for free discussion.

The Swiss universities are broad and liberal in the highest degree. Statutes are passed in their senates with simple reference to elevation of character and usefulness, and with no apparent thought of the sexes as separate. These statutes, when presented in council, are treated in the same spirit, and the question as to the advisability of coeducation came first in every university after women had already entered and studied. The original statutes excluded no one, and consequently when—after generally a remarkably long time—women applied for admission, their names were taken exactly as those of their brothers were taken; they took their places among these and worked there undisturbed until some other consideration brought the question forward. It is difficult to see why it should have been so long after the establishment of the universities before women asked to work in them. In Zurich it was thirty-one years, in Berne thirty-eight, while Basle was disturbed first last year by the question. Lausanne, however, which begins its career as a university this autumn, begins with women students. In Zurich and Berne it may have been the development of the universities from schools originally founded for the aid of callings as yet unthought of for women which caused the indifference on the part of women toward them. However that may be, when in the sixties women applied for admission in Zurich—the first one was a foreigner—no question was raised; she entered and took her degree. Ten years later, when so many, chiefly Russians, came with insufficient preparation, a new law was passed regulating the admission of "students" into the university, and formally recognizing women. It had formerly been sufficient for foreigners to present good passports from their Governments; but the new law required in addition testimonials of character and of sufficient previous mental training. If this were not produced, the student must take an examination. This examination, partly oral and partly written, must evidence sufficient knowledge of German to read and to follow a lecturer; sufficient knowledge of mathematics and the sciences to enable the student to understand the university lectures upon these subjects; knowledge either of Latin to read and understand an easy author, or to the same degree of French, with either Italian or English. The Council supported the wisdom of the university senate, and these remain the requirements of the university. Swiss students present diplomas or reports from the Zurich gymnasium or its equivalent; and here girls are somewhat at a disadvantage, for, when the framers of new educational privileges were establishing this canton school which should fit boys for the higher work of the university, they made no such provision for girls. During the early years, while education is compulsory and the state furnishes all books and industrial implements, boys and girls study together; but in the higher schools they are separated, and the courses of study in girls' schools are not so complete as in the gymnasiums for boys. As soon, however, as girls asked for admission to university work, good private schools sprang up, and the normal school was also resorted to. The normal school in Zurich now sends out almost every year, in addition to its well-equipped teachers, at least one or two girls fitted to take the *Maturitäts* examination in either the medical or the philosophical department of the university. At present, moreover, a bill is before the school commission of the state, asking that the canton school be opened to girls, and has, it is thought, fair prospect of being at last adopted.

It was in Berne as in Zurich. Women had studied several years in the university before the question of their admission was ever discussed. The Constitution used only the general term "student," and naturally girls were accepted as soon as they presented themselves. No one could have given any authority or reason for rejecting them. There were five the first year, one of these an American, it is interesting to know, who wished to study medicine. The next year there were twenty-six. The attention of the faculty was arrested: a question arose as to the advisability of simply allowing them to study under the negative provision of the university laws, and a difference of judgment was manifested; but the discussion finally resulted in the passage of a new resolution in 1874, formally defining the terms of admission for students, and including women. Since then there has been absolutely no question; young men and women work together under exactly the same conditions, and there is perfect harmony, except, perhaps, an occasional unbusiness-like discontent on the part of laboratory students, brought about by their voluntarily extended courtesy toward young women, and the thoughtlessness of these in acceptance of this courtesy. There is only one point of difference in the admission of men and women: men are not asked if they are of age, and if everybody is willing to have them take the university work; girls are.

Basle met the question first, as stated above, a little more than a year ago, one young woman having applied for admission. They were somewhat more conservative in this university, from their long-undisturbed serenity of masculine atmosphere and outlook, and this little rising of woman-ambition touched into life a small cyclone of opposition. The earnest testimony, however, of universities which had tried the experiment allayed the storm, and the young woman bravely entered upon her work and continued through the year. At the close of the year the university acknowledged that all was thus far satisfactory. In every university, we need to remember, the terms of admission, conditions of study, and all requirements, are exactly the same for men and women. It is just as in our own high schools.

For simple admission to candidacy for the degree of Doctor of Medicine, the terms are the same for all, and are determined by the university senate, with consent of the state Educational Council. But if a student wishes to practice in Switzerland, the General Government must prescribe the terms, which it does as follows: The student begins with the *Maturitäts* examination, before alluded to. This makes the following requirements:

A. Languages.

1. Latin. 2. Greek. 3. The mother-language.* 4. A second Swiss national language. 5. The Greek may be replaced by a third Swiss national language, with the same requirements mentioned in section 4.

B. History and Geography.

6. Ancient, mediæval, and modern history, physical and political geography.

C. Mathematics.

7. Algebra. 8. Geometry. Plane trigonometry, and the simplest propositions in spherical.

D. Sciences.

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* German. The "second" and "third" national languages mentioned in 4 and 5 are French and Italian.

9. Natural History. 10. Physics and Chemistry.

Having taken this examination, and studied two *semesters*, the student is admitted to the so-called natural science examination, covering physics, chemistry, botany, and zoölogy, with comparative anatomy. At the end of five *semesters* comes the examination in anatomy and physiology, partly written, partly oral. In this the student must explain some anatomical preparation placed before him, answering questions on anatomy; and must make and explain some histological preparation. He must also prepare a written thesis, within closed doors, upon some physiological subject. The proper oral examination covers anatomy, histology, embryology, and physiology.

Lastly comes the real doctor's examination, which is practical (including written) and oral. The practical embraces—

1. Pathological Anatomy. 2. Pathology and Therapeutics. 3. Surgery and Surgical Anatomy. 4. Obstetrics. 5. Ophthalmology. 6. Medicine and Hygiene.

After all this comes the formal oral examination, covering—

1. General pathology and pathological anatomy. 2. Special pathology and therapeutics, including children's diseases. 3. Surgery. 4. Obstetrics, including women's diseases. 5. Hygiene. 6. Medical jurisprudence. 7. Psychiatry. 8. Theory of medicine.

Such are the examinations required by the Swiss Government of all who practice medicine within its borders; and no thought is given by its universities as to whether the applicant for permission to practice is a man or a woman. The person must only be ready on application, and numbers of girls have justified this confidence. Students of all lands may take the doctor's degree from any department by passing successfully a final examination prepared by the university faculty. All, on the other hand, may be admitted to these other state examinations; and ambitious ones are sometimes found, even among girls, who accept the opportunity.

Up to 1883 the whole number of students who had matriculated in the University of Zurich was about 6,700, of whom 284 were women. One hundred and ninety-one of these women were students of medicine, 91 of philosophy, and two of jurisprudence According to nationality, they may be classified as follows:

	Russia.	Germany.	Austria.	United States.	Switzerland.	Other lands.
Medicine	119	12	7	28	10	15
Philosophy	49	13	7	5	11	6
Jurisprudence	1	..	..	1	..	..

Thirty took the doctor's degree—23 in medicine, 3 in pure philosophy, 4 in science, or philosophy of the second class, as it is called.

Up to the present year, since 1833, the number of male students matriculated is about 7,300 in round numbers, of whom 988—more than one eighth—have taken their degree. Since 1864, the year when women entered the university, the number of women matriculated is 484, of whom 57—more than one ninth—have taken their degree. The women graduates are classified—

	Russia.	Germany.	Austria.	United States.	Switzerland.	Other lands.
Medicine	9	5	4	6	6	5
Philosophy I	1	2	3	4	1	1
Philosophy II	7	1	..	2	..	..
Jurisprudence	..	..	..	..	1	..

From the establishment of the university up to the present date, the whole body of graduates may be thus classified:

	Jurisprudence.		Medicine.		Philosophy I.		Philosophy II.	
	Men.	Women.	Men.	Women.	Men.	Women.	Men.	Women.
1833–1864	30	..	182	..	16	..	21	..
1864–1890	79	1	249	35	101	12	310	9

In addition to the examinations taken, each graduate prepares a thesis upon an assigned subject, and these publications are of no small worth. A study of the subjects convinces one that in this way the results of a vast amount of original investigation in science, literature, and philosophy have become common property. And there are also many other publications, not only from graduates, published after the final theses, but also from those who have taken partial courses—publications of considerable interest and importance. It is impossible to follow these young women through their after-lives and describe their various services to humanity. The one jurist, Mrs. Kempin, of Zurich, is perhaps the only woman in America now giving lectures in a college for woman students of law. Miss Helene Webster, a graduate of 1889, now holds the chair of Philology in Wellesley College. And so one might name others. But, from an investigation of their university life, one can judge whether the enlarged vision supposed to result from higher education probably followed in their cases, and whether the privileges were wisely bestowed.

In the first place, knowledge that the university doors stand open leads to the formation of earnest purpose and to a wise disposal of hours and energies in the early years of life, while character is forming a good foundation. The work of these young women in Zurich, after admission to the university, proves this. Professors testify that their conscientious fidelity to tasks imposed and their earnestness manifest an influence not only on the character of the final theses, but also upon the general standard of scholarship in the university, because the whole body of students becomes more industrious; and following this naturally the standard of the lecturers must be correspondingly raised. It is claimed that the requirements in examinations are rather higher in Swiss universities than in those where women are not admitted to equal privileges. The students themselves grant that the influence is good by their cheerful acceptance of the conditions and their business-like adjustment of each other's rights—men and women together as men and men together, according to rules of refined courtesy. A tutor from the University of Vienna visited Zurich during the past winter for the purpose of observation, because an appeal had come from women in Vienna for admission to study. He was much impressed by the air of order and business which the class-rooms everywhere presented. The live interest which pervaded everything and absorbed all thought of self or sex in delight of new power to see and do, was incomprehensible to him. Such earnest preparation and such sensible recognition of favorable conditions and devotion to a chosen work must make women who will be powerful afterward in the general work of elevating humanity: and when all the world's universities thus join hands in developing all the forces God has placed latent in men and women, the full light will sooner shine into corners which are as yet mysterious and only tempting to man's curiosity or tantalizing to his needs.

CHINESE BUDDHISM.

By WARREN G. BENTON.

IN a former paper, on the Taouist Religion, it was the purpose of the writer not to dwell upon the strictly historical features of the subject. That has been done by others, whose conclusions are recorded in books and encyclopædias which may be consulted. But the object aimed at was to give as true a picture as possible, in small space, of the practical workings of the system at the present time.

In writing of Chinese Buddhism the purpose is not to enter the historical phases of the question, but to show the present status of this ancient faith in the land of its adoption.

Historians generally agree that the religion was invented in Hindostan, about six centuries B. C., and that it has spread throughout almost all of Asia, until it is to-day the religion of at least a third of the human race. To have lived so long, and reached so wide a field in its conquests, indicate elements of vitality not frequently matched in the world's history; and, while its origin, as well as its founder, is so far back, as the annals of history go, as to be shrouded in mystery, and even by many attributed to mythology, yet that it still lives and thrives as the most widely accepted religion none can deny. A reason for this fact must be sought in other directions than the perversity and ignorance of human minds, which incline men to accept absurd beliefs as a substitute for truth, as many assert.

There must be somewhat in a system of religion or philosophy which accords with human experience, and which tends to better the condition of life, and to foster hope, in order that a decade of centuries may pass without witnessing any diminution of its power. It is not sufficient to assume that its being a system of ingeniously woven myths is sufficient to account for its ready acceptance by unintelligent and unscientific Oriental minds. For even New York and London, as well as other centers of intelligence in our own civilization, have their rapidly growing theosophical societies, whose members include men of intelligence. These have formulated, according to their own fancies largely, what they are pleased to call a Buddhist creed; and, while they do not build temples, and ornament them with wooden images of their patron saint, as do their Oriental brethren, yet they none the less ardently declare their belief in the cardinal teachings of the system.

There is a tradition among Chinese scholars that, not far from the beginning of the Christian era, a rumor reached China that a great reformation was going on to the westward, and the emperor sent a committee to investigate the matter and report. The committee went overland through Burmah into India, inquiring at each stage of their journey as to the reports. In this way they encountered the promulgators of the Buddhist faith, who, on learning the object of their visit, informed them that their journey was at an end, and that they had found the true religion. On investigating the subject, the committee returned and made a favorable report; whereupon the emperor announced that the religion of Buddha was good for the people, and adopted it officially as one of the state religions of the empire. From that time the Buddhist missionaries found China a "field already white for the harvest," and it was at once recognized as the chief religion of the people, and has continued such ever since. Some scholars in China believe that it was the founding of Christianity that had reached their country; and that, had the committee continued their journey farther, China would have been among the first nations to adopt the Christian religion, instead of, most probably, the last people now likely to adopt it as a nation. The idea opens the way to much speculative fancy, but it lies outside the purpose of this paper to pursue it.

The first thing to attract the attention of one investigating Chinese Buddhism is the many points of similarity in the details with the Roman Catholic system. So striking was this resemblance, that the first Catholic missionaries declared that, in some manner, their own faith had preceded them; and that the Buddhism of the twelfth century was really copied from, or a perversion of, the Roman faith. But, finding that dates did not justify this solution of the matter, they then asserted that the devil, in anticipation of the true religion, had planted a counterfeit (older than the original), for the express purpose of preventing the people from accepting salvation when it was offered to them. This is hardly made clear enough to meet the inquisitive mind in seeking a solution of the matter.

While in China, investigating this subject of the "Religions of the Orient," I visited many Buddhist temples, conversed through interpreters with many priests and laymen on the subject, and put up at temples for weeks at a time, studying the methods observed in the semi-daily worship or performances; and reached certain conclusions which may have some interest to others. And in what I shall say it shall be my endeavor to treat of the present status of the ancient faith as exemplified in the present generation of believers, leaving the reader to form his own conclusions. I am not an advocate for or against the system, and shall seek to view it impartially.

In the first place, the present generation of Buddhists give but little or no thought to the origin or founder of the faith. There is apparently none of the controversial element in them. They ask no questions and have no doubts. That Buddhism exists, and meets all their requirements in the religious line, they know; and with that they are content. All efforts to dislodge this ancient faith are met with the most aggravating indifference; and such as have nominally adopted the Christian system have apparently not abandoned the old, but simply taken on another additional string to their bow. With most men, one religion is sufficient, but not so with pagan John. In this respect, indeed, the "heathen Chinee is peculiar." The same individuals believe in and practice no less than four different systems of religion. Taouists are also Buddhists, and Confucian disciples recognize both systems; while all together, and even the Mohammedans—of whom there are many in China—recognize the state religion, of which the emperor is the representative and custodian. And it is said that many Roman and Protestant converts also adhere to their former belief in the native articles of faith.

Buddhist priests are not, as a class, educated in any legitimate sense. They mostly are able to repeat from memory the ritual of the faith, and many include in their mental storehouses a literal memorized text from the "classics"; but in matters of general interest they are often the merest children in knowledge. They are recruited from all classes of society, but most generally from the so-called literary class. They are strictly celibates, and are vegetarians in living. Priests are exempt from the law which requires every other male Chinaman to wear the crown-locks braided in a queue, while the rest of the head is smoothly shaved.

Formerly the custom of scalp-taking in the event of conquest was observed by the Tartars and Chinese (from whom the custom was handed down through their successors in this country, he Indians); but when the Tartars subjugated China they issued a decree that all who would shave their scalps, except the scalp-locks, in token of subjection, and wear that in a braided queue, to be ready to be removed if emergency should arise, would have their lives spared. It is not recorded how many refused to accept the conditions, but the queue on the head of every Chinaman to-day is the flag of truce, as it were, and by it he is counted loyal to his conquerors; but the priests were exempted from this rule, owing, no doubt, to the custom already in vogue among them of shaving the head clean as a mark of humility.

The priests live in the temples, having no other home. The temples are located in the most inaccessible places in mountains and on islands, and often cover acres of land. They are void of architectural beauty or effect, and consist of a main auditorium, with a succession of sheds attached, windowless and plain. The main room is furnished with an altar, on which is placed an image, generally of wood, of Buddha, sitting upon an imitation lotus leaf, and on either side of this image are other images of lesser lights in the calendar of saints who are supposed to be especially celebrated in Buddhist annals. In front of these figures incense-sticks burn day and night. These are made of dried aromatic wood reduced to fine powder and mixed into paste with oil and then put on splinters of dry wood, the lower end of which is stuck into a vase of sand and the upper end lighted, which burns slowly without a blaze, the curling, slender volume of smoke shedding forth an odor which counteracts the damp, musty smells of the old stone walls and sunless rooms.

The sheds attached serve as living-rooms for the priests and as guest-chambers for pilgrims and travelers.

At intervals around the walls of the audience-room stand the images of other saints in the calendar, which includes eighteen or more principal characters. These are not intended to represent deities, as many people suppose, but simply symbolize and preserve the memories of the men who figured prominently in the past history of the religion. They are supposed to represent also certain ideas connected with the conception of certain attributes, such as Love, Mercy, Justice, War, etc., and each figure has been made to convey the idea of his specialty.

For example, the Love symbol is shown as a fat, jolly-tempered man surrounded with little children at play. Justice sits with a face utterly devoid of all traces of sympathy, and with eyelids drawn down and lips firmly closed, and, with drawn sword, symbolizes the fate of the evil-doer. Thus, each figure is intended to impress the observer with a proper observance of the graces inculcated in the religion. But they are not worshiped. Nor has Buddha been deified in any proper sense, but is looked upon as the founder and best example of the faith. So far as I can judge, no prayers are offered to him as such, but, while he occupies the post of honor in all temples, he is merely venerated as above indicated.

Morning and evening services are observed in the temples, which consist of a certain number of strokes upon a great bell and a similar number of taps on a huge drum, which sometimes consists of a section of a hollow trunk of a tree, with rawhide fastened across one end; and this noisy demonstration is preceded and followed by repetition of ritual, and bowing and kneeling in turn in front of the central altar. Nothing can be more weird than to listen to the beating on the drum and bell in the stillness of a mountain gorge at sunset, where no sound except the occasional howling of tigers near by comes to break the monotony of the mountain stillness. I can well understand how it affects the minds of ignorant worshipers, inspiring in them an awe equal to that produced by the most profound ceremonies of the churches on the minds of the worshipers.

They have no set days for the people to come to the temples to worship. The priests keep up the service above named at sunrise and sunset of each day, and the laity may come to the temples at any time they see fit. Prayers are said for the people, or rather by the people, in a sort of lottery scheme. A joint of bamboo, open at one end, is kept in the temples, in which are an assortment of prayers and omens good and bad. The worshiper (?) selects one of these by chance, much as we sometimes see children pulling straws for the longest or shortest to decide some question in dispute. If the first effort gets an undesirable "prayer," it is put back and another drawn. This is repeated until the worshiper gets one that suits him, and then he goes on his way, feeling sure that the blessings of Heaven will rest upon his undertakings.

There are monasteries and convents in addition to the temples, and these are carried on for the same purposes and very similar in all respects as the Roman institutions of the same nature.

Among the tenets of the faith is one commonly called "works of merit," similar to and for the same objects as supererogation —that is, doing more good than the present emergencies require— for the purpose of having a balance to one's credit in case of emergency. Priests under such pious inspiration go into the markets and buy squirming eels of fish-mongers and liberate them. Paying for them with money first begged from door to door. The relative merits of buying these eels and giving them to the hungry for food have not occurred to them; but they are not the only people who take the least probable route to gain favor in the sight of their final Judge. Acts of personal torture and self-denial rank high in the line of "merit," and men are not infrequently met with who inflict the most atrocious penalties upon themselves in the vain belief that it will gain them high standing in the eyes of the powers that control their future destinies. The people can not understand disinterested benevolence; hence, when missionaries go among them and apparently put themselves to inconveniences to induce the people to accept their teachings, they are looked upon with a certain respect; but their actions are invariably construed as being "works of merit," and that, instead of their good, it is the future good of the missionary himself which he is looking after.

I knew an English missionary who went into the famine district, twelve years ago, to distribute the relief sent there from England; and the chances were ten to one that he would never return alive. Yet the people admired him as being piously seeking to lay up treasures in heaven to his own credit.

But the leading characteristic of the Buddhist faith, and the one in the light of which all their actions and observances must be judged, is the doctrine of transmigration of souls. In this belief lies whatever of practical good comes from the system, in addition to the rest of mind and contentment which come of one being entirely satisfied with his faith. It is urged by religious people in this country that the disciplinary benefits arising out of the belief in a future state of rewards and punishments are apparent in and essential to good society; that if a belief in this doctrine be annihilated, society would lapse into a state of barbarism and outlawry. Without entering into any discussion of this question, it is sufficient to say that the restraining effects of the belief in transmigration are an equally strong motive for right-doing.

They believe that life is a succession of existences, and that every grade and condition of life are the product of a former career. All animals are equally immortal as men; and, in fact, the souls of all are identical and interchangeable. Hence, to kill an ox or a dog is as much murder as to kill a man. So strong is this belief, that no Buddhist will take the life of an animal for food, the pig and fowls alone excepted. But for the contingent of Mohammedans in Chinese cities, Europeans would fare badly for beefsteaks and lamb-chops. I never knew a Chinese butcher who was not a Mohammedan; and when Mohammedan butchers buy fatted cattle of pious Buddhist farmers, they have to promise that the cattle shall not be slaughtered. I once asked a fish-dealer why he made a distinction in his line. He said that he never killed fish, but that when taken out of the water they died. I suggested that if he were to reverse this rule and put an ox under water, he too would die without being killed. When, however, the soul of an animal has departed, the carcass is exempt, and finds ready takers among the faithful who are not averse to eating beef. It is from this fact that all animals having died natural deaths are used by the people as food. The only exception to this rule of eating dead animals is in the case of their having belonged to a priest. I once shot a priest's dog, and it was buried with great ceremony (at my expense), and, when asked why they did not eat it, was told that being a priest's dog it was sacred. That made, of course, a great difference!

The beneficial results from this belief are apparent in the kindness to all domestic animals. No need for Mr. Bergh's society there. When a farmer harnesses his faithful ox or cow to plow his field, he treats the beast with the utmost consideration, for the reason that, for aught he knows, he has harnessed the soul of his own grandfather; and that the soul of the beast is watching him, and knows just what he is doing, he does not question.

Buddhists accept the proposition that one's relative rank, whether as a poor man, or, next thing to that, a pig or a donkey, is entirely due to his actions in a former life. And no matter how humble one's lot may be, he devoutly hopes for promotion in the next *inning*. One of the most potent fears in the minds of many men is that they may be born next time as a donkey. With us the difficulty is that sometimes men are born donkeys but do not appear to know it.

The old problem of how long it will take a frog to get out of a well twenty-one feet deep by jumping seven feet every day and then sliding down six feet at night, aptly illustrates the Buddhist's idea of the problem of existence. How many lives or succession of ages must one live in order to get into the final haven, or Nirvana, whatever that is, is the question. He believes this depends chiefly upon his own conduct, hence the belief has the tendency to restrain the vicious to discipline. How well this motive succeeds is apparent when we consider the unmatched population, both in numbers and in poverty, and then consider the comparative immunity from crime. True, the civil law punishes crime severely; but so it does in other countries, but this is thought not to be sufficient.

In China, where there is not a burglar-proof safe, and no constant surveillance of policemen, there is comparative security to life and property. It is apparent that the belief in the transmigration doctrine has a repressing influence in this direction. But the people are not, as a rule, as good as their religion would make them if it were practiced. But in this, again, they are not peculiar. The masses are grossly ignorant and largely brutalized by ages of tyranny and poverty; yet they plod on in patience and industry, waiting their final rescue from existence.

The bible of the sect is not without beauty and high moral as well as poetic conceptions. There is much in it of the nature of mythology and mysticism, which Buddhists do not pretend to understand themselves, yet there is much to admire. From a book of extracts and translations from the Buddhist bible I give a few examples:

"The perfect man is like the lily, unsoiled by the mud in which it grows." Another: "The perfect man will not be angry with him who brings him evil reports of himself, lest he be not able to judge truthfully of the matter whereof he is accused." Its moral code contains such rules as "Do not steal"; "Do not lie"; "Do not kill"; "Do not be a drunkard"; "Do not to another what you would not wish done to yourself." From these examples it may be observed how nearly their moral law runs parallel with our own; and that this has exerted a potent influence in forming the Chinese character is evident. Also, that they cover the cardinal rules of right living in good society, none will question.

The system offers motives in the way of rewards for right living, and punishments for evil-doing. It develops sympathy, the source of many virtues. It teaches the equality of all men. One man is better or worse than another only as he observes the laws of good society or breaks them. That it satisfies the minds of its votaries is certain. The Chinese will never abandon this ancient faith on sentimental grounds. They must be convinced that a better system is offered before they accept it.

Whether this demonstration is forthcoming, remains to be seen. Strong efforts are being made in that direction, and the future alone will reveal the outcome.

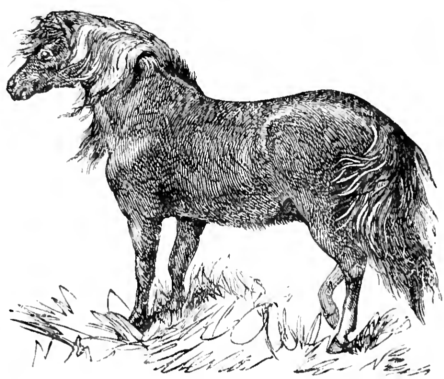
Rear-Admiral Belknap, of the United States Navy, combining his discovery of the greatest oceanic depths yet found in the Japanese Kuro Siwo with what other explorers have found in different oceans, announces the conclusion that, "as a rule, the deepest water is found, not in the central parts of the great oceans, but near, or approximately near, the land, whether of continental mass or island isolation."

SHETLAND PONIES.

THE Shetland pony has been invested with a halo of romance somewhat out of keeping with the prosaic surroundings of its native home; and this, apparently, from a very early date, for we chanced to read not long ago that, traditionally, "the Shetland pony was carried from the Caucasian range, by ancient worshipers of Odin, to Scandinavia, thence to Shetland"—in which tradition we discern a trace of humor, if nothing more, as, considering the size of some of these animals, they are much more fitted to be "carried" than to transport any one, whether from the Caucasus or elsewhere. But this is not all. Not only is the origin of the breed thus presumably lost in the mists of antiquity; a number of popular misconceptions also prevail in regard to the present-day nature and habits of the animals, all of which it seems desirable to correct. They are now not only drafted annually in large numbers to the south, but are extensively shipped abroad. A few words, then, in regard to the breed, as it exists to-day, may not be out of place.

To begin with, we must contend—in opposition to the popularly received belief—that there is no such thing as *the* genuine Shetland pony, in the sense of a single pure and original breed. There happen to be several distinct kinds in the islands, and these, besides being subject to natural variation, have been further increased in number by crossing. Crosses apart, however, an Unst pony is very different from a South Mainland one, while both of these again differ from a Fetlar specimen. There are also Fair Isle and Bressay varieties. It would be invidious to seek to indicate in this paper which of these is to be considered the best. Each kind, no doubt, has its special excellences, but a sufficient latitude is perhaps allowed when we state that a pure-bred pony may be anything between, say, thirty-six and forty-eight inches high at the shoulder. A small-sized pony, again, is not necessarily any better or more valuable than a large one; though for certain purposes, such as working in coal-mines, the smaller animal only is employed. As a general rule extremes of size, either way, fetch correspondingly extreme prices.

Broadly speaking, the ponies to be seen throughout, say, the mainland of Shetland—and they are to be met with everywhere, in spite of reported scarcity—may be divided into two classes, those kept by large breeders, generally in fenced parks, and the proletariat class employed by the peasantry in labor. Strings of the latter may be seen any day upon the roads, dragging peat-fuel from the hills in Lilliputian carts. They are wonderfully tough and strong for their size, live upon hard fare, and require, or at least receive, little attention. Numbers of them live out of doors all the year round, except in the severest weather. The time-honored fiction that they are habitually left out in the snow, and preserve themselves from being drifted over by walking constantly in a circle, contradicts itself. As a matter of fact, snow often lies for seven or eight weeks in Shetland, covering the ground to a great depth. Under these circumstances the animals, if exposed, would certainly succumb, and they are far too valuable to their owners for this to be permitted. But they certainly do rough it out of doors in very inclement weather, seeking the doubtful shelter of dikes and out-houses; while in hard seasons the stud of the breeder is carefully housed in sheds made for the purpose. Unquestionably these ponies can stand a great amount of exposure, being fitted for this by a double or treble thickness of coat. But it is very much to be questioned—the popular belief to the contrary notwithstanding—if any of them are the better for being subjected to an extreme test of this kind. Ponies sent south at an early age rarely, if ever, pass through such an ordeal, and it is not found, we believe, that *their* natural hardiness deserts them, or even diminishes, when they receive fair treatment and proper shelter during inclement seasons. If stabled, however, as in many cases they must necessarily be, by the southern buyer, they should have abundance of fresh air; a simple shed, by way of cover, is almost all that is necessary for them. And it is imperative that at all times they should have ready access to drinking-water. No animal can exist so short a time without it unharmed. It is self-evident that, if a pony be entirely dependent on outdoor feed, his condition must necessarily vary with the season. Apoplectically full in summer, he must be sorely reduced in winter. This must, sooner or later, injure the health and stamina of the animal.



A Shetland Pony.

The writer, who has had considerable experience in the keeping of Shetland ponies, has carefully experimented as to the best hygienic arrangements for their indoor accommodation. He finds that a rough stone building, loosely cemented, so as to allow a free current of air to pass through the walls, with ordinary stable fittings on a small scale, and covered with a galvanized iron roof, forms their best shelter. During the day, in almost all weathers, they should have their heads loose, in rough pasture; and in summer they can safely be left out at night, with the exception of young foals. Strange to say, the latter are remarkably delicate. For indoor food common wheaten bran made into a mash, with the addition of a little Indian meal, suits them much better than oats; while hay or straw, with turnips or potatoes, and perhaps a little linseed cake, complete their stable dietary. Generally speaking, they are somewhat gross feeders, and, though capable of standing unharmed a surfeit which would ruin an ordinary horse, they should have a carefully measured allowance, varying according to their size and to the work they have to do.

Now, as to the much-vexed question of height. A variation of, say, three hands between the average large and small sized ponies means a good deal in the case of such a tiny animal. Yet it obtains, as we have said, among undoubtedly pure-bred specimens, and entirely independent of any foreign cross. Accidental variations of size occur, of course, in breeding, and may be perpetuated, though this is not always to be relied upon. The true explanation, according to one of the most experienced of Shetland judges, is that size is mainly, though perhaps not entirely, a question of *feed*. Scanty feeding on hard pasture tends to diminish the height, and also to develop that superabundance of hair which is popularly (though erroneously) regarded as one of the distinguishing marks of the genuine strain.

The craze for undersized ponies, in our opinion, has had its day. Except as curiosities, or for the purposes of the *ménage*, these pygmy animals are practically useless. The conventional Shetland pony—the animal represented in picture-books—namely, about forty to forty-four inches high, very tight-jointed, and with an impossible growth of hair all over him, is just about as bad a type of this famous race as can well be imagined. From his build he is generally short-winded and thoroughly impracticable in his paces. A South Mainland specimen, on the other hand, long and rakish in build—hard-grown, as the saying is—and clean-limbed, will far surpass his companion in staying power. One of this hardy breed—in our opinion the ideal Shetland pony—has been known to travel from Sumburgh to Lerwick and back the same day, with a tolerably heavy riding weight, say fifty-six miles altogether of extremely hilly road. But, minor differences apart, there *are* certain characteristics—unfailing tests in their way with the experienced judge—which go to the "make-up" of a Shetland, as distinguished from an Iceland or Faroe, pony—e. g., a certain unmistakable breadth of build, set of pasterns, and, more particularly, an apathetic air which no other breed possesses. Your "Sheltie" is not a quick animal, is inclined to be sleepy rather than otherwise in his paces, and is, as a rule, disposed to do no more than he can help in the way of exertion, though, if put to it, he evinces great power of endurance, and will go through an immense amount of work for his size. The Iceland variety is altogether inferior, shorter-lived, narrower in build, and generally fallacious, but, with all this, he is quicker, livelier, and lacks that air of pensive melancholy which haunts every Shetland pony. Our advice is to avoid the inferior animal, however highly recommended. Their price is, roughly speaking, about half that of the Shetlander, but the money is ill-saved. The average life of an Icelander is about twelve or thirteen years, while the other will live to twenty-five or even more.

During the earlier months of spring, before the snow has fairly disappeared from the Shetland uplands, the American buyer travels over the length and breadth of the isles, picking up every likely animal he can find for the foreign market. In order to secure a good selection it is necessary to forestall him. Hence mid-winter is the best time to buy. Just at present there is a comparative scarcity of fine animals in the islands. Within the last three years, and even before that, a disease affecting the ponies, incurable save in the earlier stages, and called sarcoptic mange, ravaged many districts. Infected animals were freely slaughtered, and the epidemic may be said to have spent itself. Still, the ponies are fewer than they once were, and the price all round is considerably higher. At present it may be said to range from £10 to £30 and upward for three-year-olds. It is impossible, however, within the limits of this paper to instruct intending buyers. The prices are very variable, as the animals often pass through several hands before reaching the ultimate purchaser. The latter will probably be victimized if buying from so-called agents in the south, as the latter will endeavor to extort £18 or £20 for an animal which has cost them little more than half that sum in Shetland. The only safe plan is to purchase through a respectable dealer on the spot.

The variety of coloring in these tiny animals is extraordinary. Almost every possible—and some all but impossible—shade of horse color may be seen during a day's ride through the mainland, from the lightest fawn, almost white, by gray and slaty shades of gradation to brown and black. There are no dapple-grays that we wot of. There is a tradition, of the usual value, that brown is the "true and original" hue. Cream ponies, if otherwise good, fetch a higher price than others, as being a "fancy color," and the same may be said of "piebalds." The theory that light-colored animals are not so robust or hardy as dark ones is not borne out by observation. A stripe, or ribbon-like mark, down the spine is a sign of Norwegian blood, the infusion dating many years back. If the Caucasian legend is to be relied upon, however, the Norway pony is at least first cousin to the Shetland one.

A mob of ponies feeding together in the open air will use their heels to each other most liberally. This is a painful but undeniable fact, known to every breeder. When running wild on their native hills they are extremely pugnacious, and will fight most determinedly, not only with each other but with larger horses, frequently to the discomfiture of the latter. So far true, but our romancer—the Shetland Munchausen—goes on to affirm that if

"Fib and Tib and Pink and Pin,
Tick and Quick and Jill and Jin"

are but congregated loosely together in a shed, or other building, they will no longer quarrel. Amity will reign where hopeless discord formerly prevailed. We can only say, Try the experiment! We have. The whole thing is a baseless fiction. They are patient and enduring, these ponies of Linga;* in many cases they may be trained to a docility and sagacity almost human, but there is a point with most of them—such, at least, is our experience of them indoors as well as out—when their patience gives way to positive ferocity, and when once their blood is up they are not so easily pacified. An experience we once had with a recalcitrant riding pony in a rural smithy—it was his first shoeing—will never fade from our recollection, nor, we imagine, from that of the village Vulcan.

Never groom a Shetland pony as you would an ordinary horse. They should be well brushed, and their manes and tails combed; but the indiscriminate use of the curry-comb is positively hurtful to them. More especially is this the case if the animal is to be left much out of doors. Observe one of them in the open air on a wet day, and you will notice that the rain runs off his coat as off a duck's back. But if the "set" be removed, the coat will no longer be water-proof. It is scarcely necessary to add that, by immemorial custom, the mane and tail should be lightly trimmed and no more. Nothing can be more incongruous than the sight of one of them closely cropped. The tail should just be off the ground. So careful are Shetland dealers in this respect that we have often received animals dispatched by them with the tail thoughtfully tied in a double knot, in case of accidents on shipboard.

The Shetland pony is shy of a strange owner, and at first requires to be jealously watched in a new home, as being apt to bolt on the first opportunity. Unfailing tradition steps in here and gravely informs us that a straying pony, however far removed from the land of its birth, will invariably shape its course for the north—in the direction, that is, of its native home. Needless to

* Linga, or Heath Isle, the ancient name for Shetland, now on the *lucus a non lucendo* principle, heath or heather being practically extinct.

say that, by preference, it does nothing of the kind. As far as our experience enables us to judge, a straying pony, wherever it may be, traverses the line of least resistance.

We have said that they are exported in large numbers annually. The wonder, in our opinion, is that they are not still more extensively purchased. They are singularly affectionate and repay any amount of attention. Their uses are manifold, as they are capital saddle animals—one of forty-seven inches being quite up to an ordinary riding weight—are as a rule sure-footed and reliable, go well either singly or paired in harness, make the best of hill ponies, give little trouble, and are the most captivating of all possible pets. Take them all in all, they are by far the best of the pony race. Perhaps their only drawback is their almost infinite teachableness, which tends to make them acquire bad as well as good habits; but this is a question of training. In nine cases out of ten their breaking-in is intrusted to inexperienced boys, with the usual result of developing a tendency to shy or to throw their rider, at which latter manœuvre they may become perfect adepts. These tricks are never unlearned. But, with an ordinary amount of skilled attention from the first, they may be perfectly disciplined.

Mr. J. Sands is the poet of this special subject—perhaps the only singer the Shetland pony ever had. In touching verse he pictures the mother pony with her downy foal feeding together on the wind-swept grassy hills of Shetland, the latter soon to be parted from her to go to work in the grimy coal-mine. A fine touch of nature this, but not without its share of, apparently inevitable, fallacy. For mine-ponies, though certainly condemned to life-long imprisonment, are well looked after and carefully tended. Assuredly their lot underground is preferable to ill-treatment above ground, and though a pony may suffer from something like "home-sickness" for a few days in a new dwelling, the attack seldom lasts long. Our pony, though somewhat of a pessimist, is a philosopher, and adapts itself with wonderful facility to a change of home and ownership.—*Cornhill Magazine.*

One of the traits of recent historical investigation, which is well illustrated in Welzhofer's History of the Early Greek People, is its reaction against the skeptical school of inquirers. The disposition to disbelieve the old stories, or to resolve them into poetical fancies, is giving way to speculations concerning the real facts on which they may or are supposed to have been founded. Mr. F. T. Richards suggests, in the Academy, that anthropology has done something to bring about this change of mind, by finding, still existent, institutions, incidents, legends, and states of mind closely parallel or akin to early Greek and Roman affairs; while the credit of many of the old stories is strengthened by incidents in which the unlettered traditions of savages have been found to be true.

SKETCH OF JEAN-CHARLES HOUZEAU.

THE romantic incidents of M. Houzeau's career in the United States must invest his story with a living and lasting interest to all Americans. His scientific record is no less remarkable. In versatility, variety of studies, industry, productiveness, and originality he has been surpassed by few men of science. The materials for this sketch have been drawn from the affectionate and appreciative Notes biographiques of Houzeau's intimate friend and associate, M. A. Lancaster (Brussels, 1889).

JEAN-CHARLES HOUZEAU DE LEHAIE was born at L'Ermitage, near Mons, Belgium, October 7, 1820, and died July 12, 1888. He was the elder of two children; his brother, M. Auguste Houzeau, is a professor of the School of Mines in Mons and a member of the Belgian Chamber of Representatives. His mother was still living in 1889, at the age of ninety years; but his father died in 1885, ninety-five years old. His name was regularly published in the annual list of nobles in the Almanach royal. The family had added *De Lehaie* to their name about the middle of the last century, to distinguish them from other branches of the same stock.

Jean-Charles Houzeau showed very early an inclination toward the branches in which he became famous. He was interested in astronomy even before he had learned to read; and with the bonbons that were given him he would form on a table groups of geometrical figures intended to represent the constellations. When he had the table covered with them, he would call his friends in to look at his firmament. He attended the college at Mons while from twelve to seventeen years old; and in the last year received a special prize. He then applied for admission to the University of Brussels, but failed to pass the examinations. He returned to Mons, where he was allowed to pursue his astronomical studies and ramble over the fields at will. From this time his mind was always on the alert, and he showed uncommon faculties of observation. With his own hands he constructed a small observatory on a neighboring hill. It included a wooden cabin in which were a mural circle, a transit instrument, and a telescope. The tubes of these instruments were of zinc; the glasses, which were not achromatic, were bought in Paris. He also began to write about this time, and contributed to L'Emancipation, of Brussels, numerous articles on subjects relating to improvements in industrial arts. He published his first scientific work in 1839, a pamphlet of 108 pages on turbine wheels, which can not be found now, but which was regarded by competent men at the time as of great practical value.

In the two following years, 1840 and 1841, Houzeau attended the courses of the Faculty of Sciences in Paris, but did not seek an academic degree. On his return home, in 1842, he put himself into communication with Quetelet, to obtain a position in the observatory at Brussels, and was appointed a voluntary aid. He had already written a note in the Astronomische Nachrichten, on the position of the zodiacal light, which is cited by Humboldt in the first volume of the Cosmos; but so unknown was he to the scientific world at this time, that Schumacher, the editor of the Nachrichten, wrote to Quetelet to know who he was; and Quetelet was obliged to reply that he knew as little of him as his colleague.

In September, 1846, Houzeau was promoted to a recognized position in the establishment and a salary of fourteen hundred francs. The industry with which he attended to the special duties of this position is illustrated by the fact that during the three years that he held it, he, who had been so frequent a correspondent, did not contribute a single paper to the Academy. The reports of the director, however, amply attest the esteem in which he held his assistant, and the value of Houzeau's services in the work. Some of the fruits of his labors here are embodied in Quetelet's Climate of Belgium, in the preparation of which Houzeau had a large part. The astronomical observations had been interrupted for seven years, when Houzeau took hold. He contributed much to their resumption in 1848. He was usually the first one at the observatory, when any notable event among the stars was announced, to point the telescope at the designated object. Thus, in 1848, he was the first person in Belgium to determine the elements of the orbit of a comet from observations made in the same country; and, on the discovery of Neptune, he at once took observations for the determination of the new planet's right ascension and declination. In 1847 he was charged by the Government with the conduct of geodetical observations on the northern frontier, of which a few points remained to be determined. But his usefulness as an official astronomer was suddenly interrupted by the political events of 1848. Houzeau was a warm republican, with inclinations toward socialism. He had already, in 1839, when hardly twenty years old, been warmly interested in a dispute which arose with Holland, and had been among the first to join a company of volunteers for public defense. On the present occasion he gave free and unambiguous expression to his democratic principles and republican aspirations, and compromised himself by forming relations with persons whose political standing was not good. He published numerous polemical articles in the journals. On the 25th of March, 1849, a meeting at which he was presiding was broken in upon by the Leopoldists, and he and his fellow-republicans were obliged to flee. A few days afterward he was deprived of his position at the observatory for having, the decree read, "assisted at meetings organized for purposes contrary to the institutions of the country." Quetelet was discommoded by the action of the Government, and did not conceal the fact. Houzeau continued, however, to take part privately in the work of the observatory for a few months, till he started on a tour in Germany, Switzerland, and France. Sojourning at Lyons from the following February till May, he occupied himself with the preparation of several works, among them two treatises on Meteorology, which appeared afterward in the Encyclopédie populaire. In May, 1850, he settled in Paris, where he resided for five years, devoting himself principally to study. He was an industrious taker of notes, which related, not to science alone, but to all branches of human activity, and embraced anecdotes and jokes. He assisted M. d'Abbadie, of the Institute, in arranging the scientific observations which he had made in Ethiopia. He interested himself much in optical telegraphy. In conjunction with his brother he made experiments at Paris and Mons to learn if the light of the flashing of powder at one place could be seen at the other. Of course, these experiments were not successful, for such lights could not be seen at so great a distance. Some time afterward communication by the electric cable between England and France was interrupted, and Houzeau proposed to the English Cable Company to use a system of optical signals. Experiments were determined upon between Dover and Calais, but were stopped by the order of the French Government, declaring that such work should be done only by agents of the state. They were undertaken again in England, where this kind of interference could not take place, between Southend and Whitstable. The first experiments were successful, but the populace, excited by so much night-work with fires, and fancying that the oyster crop would be damaged by them, mobbed the experimenters and stoned Houzeau's lodgings.

The essay on the Physical Geography of Belgium (1853) was the first book, M. Lancaster says, in which Houzeau "gave the measure of his force as a man of science and a writer, and in which one could perceive the whole extent and variety of his knowledge, appreciate his expository talent, and enjoy the charm of his sober, clear, and elegant style." He had been collecting materials for it for ten years, and in doing so made the best use of his pedestrian excursions. The book is possessed of an interest that does not pall for an instant in the reading, and is described by M. Lancaster as one of the most remarkable works that can be cited. An important paper in the same line was a study of the influence by which the peculiar features of the relief of Belgian topography had been produced. In 1854, through the influence of his friend and former colleague, Liagre, Houzeau was temporarily commissioned by the Minister of War as astronomer to determine latitudes and azimuths and make geodetic observations in the triangulation of the Belgian coast. He performed this work with great credit to himself and advantage to the service till 1857, when, the appropriations failing, he was dismissed. About this time (1857) he published his History of the Soil of Europe—the most important work he produced prior to crossing the Atlantic. It was accompanied by a map which deserves mention as embodying the first attempt that was made, with a satisfactory degree of success, to represent the relief by curves and by successively deeper tints of shading. Berghaus had previously attempted a map with relief curves, but it left much room for improvement.

After his dismissal from the work of triangulation, Houzeau proceeded to carry out a desire which he had cherished for many years to visit the United States, where he expected to study a society and customs different from those with which he was acquainted. He embarked from Liverpool on an emigrant sailing vessel, on the 11th of September, and reached New Orleans after a voyage of seven weeks, much of the time marked by hard storms. He expected to remain in America a few months. His residence actually lasted twenty years. Full accounts of his experiences and observations during the first ten of those years are given in his twenty-four communications to the Revue trimestrielle. The letters, treating of many questions, constitute, for the time in which they were written, a complete, vivid, and animated picture of the manners and institutions, and the social, political, and intellectual conditions of the districts in which he abode. The question in which he appears to have been most deeply interested was that of the abolition of slavery. After staying at New Orleans long enough to get a passable practical knowledge of the English language, he went to San Antonio, Texas, where he was engaged in surveying for irrigating canals; then made a six weeks' excursion to the Rio Grande, during which he found abundant opportunities to carry on studies of the winds; he was interested in observations of Donati's brilliant comet and speculations as to its identity with the comets of 1264 and 1556; and was commissioned to make surveys in western Texas for the settlement of some Spanish land titles which had been acquired by a company. He describes his life here as that of the regular frontiersman.

When the civil war broke out, Houzeau was in southern Texas, about to start on a geological excursion to the borders of the Indian country. The trip occupied six weeks, and, on his return, he seems to have got himself into some trouble by assisting in the escape of a fugitive slave. After resting a month, he started for another geological excursion toward the Rio Pecos.

But affairs had become too much disturbed for the undertaking to be safe, and he was stopped before he had made more than a few days' journey. Life at his ranch was imperiled by Indian depredations, and he was obliged to abandon all—even his books and his precious collections of Secondary and Tertiary fossils, his field and his cattle—and return to the towns. At Austin he was invited to join the staff of the Confederate army, to help supply a seriously felt lack of scientifically educated officers, with the inducement added that he would thereby be enabled to avoid requisitions. He answered: "I would sooner cut off my right hand than serve that cause. Let the requisitions come; they may watch me as an obdurate or make a prisoner of me, but a soldier of the planters—never!" He returned to San Antonio, where he hoped to be able to weather the storm in obscurity; but, being threatened with a conscription, he claimed the protection of the Belgian consul at New Orleans, without effect. There was a powerful party in the region opposed to the Confederacy, and he allied himself with it. Then came the arrest, in October, 1861, of Mr. Charles Anderson, Unionist, at the head-waters of the Rio San Antonio, with the accounts of which the papers of the time were filled. Houzeau, with a Northern lady, his neighbor, formed a plan to rescue Mr. Anderson, and carried it out with admirable daring and brilliant success, himself accompanying the suspect on horseback at night to a point down the river, whence a straight road led to freedom, and taking care of his business papers. Desperate but vain efforts were made to discover the "traitor" who had helped Mr. Anderson off.

In February, 1862, Houzeau learned that the Vigilance Committee were about to make a descent upon him. He had compromised himself by defending the freedom of the negroes whom Anderson had set free to prevent their being sold by Confederate officials. He prepared to flee, first taking care to write an account of the rescue of Anderson. Knowing that the Unionist party desired to send a memorial to the President of the United States, and wishing to be useful to them before going off, he told them that if they would prepare the memorial he would take charge of it. Not being able to carry his own papers with him, he burned them, for there was not a leaf among them, he said, that did not contain something in condemnation of slavery. With the Unionist memorial stuffed in the barrel of his shot-gun, he started off under the guise of Carlos Uso, Mexican driver of six oxen, in the train of Alejandro Vidal, for Brownsville and Matamoras. The story of the journey of thirty-five days, as told by him in his correspondence, reads like a chapter of Uncle Tom's Cabin. He had to remain in Matamoras nearly a year, till January, 1863, waiting for the French blockade to be raised, before he was able to take passage for the United States. He spent his time in gardening, in drawing architectural designs for the rebuilding of the burnt city, and in making surveys of Matamoras and Brownsville for the consul of the United States. His house sheltered many Texan refugees. At last the American war-ship Kensington appeared at the mouth of the Rio Grande, and Houzeau was given passage on her to New Orleans as a member of the Belgian Academy of Sciences. At New Orleans he identified himself with the interests of the colored population, and became a regular contributor and one of the editors of their French journal, the Union, afterward the Tribune, to which he added an English part. He came north in July, 1863, and resided in Philadelphia till November, 1864, pursuing scientific and literary studies and preparing his book on the Mental Faculties of Animals as compared with those of Man, which was published in 1872. Then he returned to New Orleans and took charge of the Tribune, which became, on the strength of his famous article, Is there any Justice for the Black ? one of the best known and influential journals of the country, contributing to it some eighteen or twenty columns a day. He presided over the Republican Convention of July 30, 1866, which was mobbed, and barely escaped from it with his life by the aid of a back passage. In the next year a division arose among the parties interested in the Tribune, with which Houzeau would have nothing to do, and he retired from it.

Houzeau had hardly landed in the New World when he received the offer of a professorship of Geology in the Free University of Brussels. He declined, but his name was put upon the programmes and kept there for two years, while efforts were continued to induce him to accept. He was disposed to consider more favorably the offer of a position in the military school, made in 1863, but the financial limitations of the institution prevented the consummation of the appointment. No settled intention, but accidents arising one after another, kept him in America for twenty years. He formed plans to return to Europe several times, but something occurred to postpone the day. In the mean time his literary and scientific activity suffered but little interruption. He contributed to three or four journals sketches of travel, American life, the Indians, the war, slavery, etc., and to the scientific societies and journals papers on the numerical calculus, the radius vector of a new planet, parallax, stellar movements, and other subjects; and, while busiest on the New Orleans Tribune, he taught stenography to a school of colored men, and corresponded with the New York Evening Post.

A few weeks after giving up the New Orleans Tribune, Houzeau removed to Jamaica, where he found a new life of freedom opened up to him with ample opportunities for study. He took a house, with a few acres of garden, at Ross View, near the foot of the Blue Mountains, and there led a life of seemingly pure enjoyment in his work, varied by excursions, of one of which, to the higher mountain regions, he has left a full and most entertaining account. The colored people of the neighborhood had borne a bad reputation, but Houzeau found them the best of neighbors. He gathered them around him and taught them the rudiments of science and something of literature. He taught the children to read, and found by his experiments that the old way of spelling the words out was better adapted to their mental condition than the "philosophical" one by presenting syllables and words to be learned bodily. He set up a printing-press, from which he issued a numerical calculator, a table of logarithms, a perpetual almanac, Families of Plants, and Correct Information about Common Things, some of which works, however, were not completed. The scientific journals were well supplied with the articles which he produced during this period. The principal of his works was the Study of the Mental Faculties of Man and Animals, on which he had labored for several years. It was warmly commended by Mr. A. R. Wallace, who said it gave the author a high rank among philosophical naturalists, and by Mr. W. Lauder Lindsay, who regarded it as the peer of Darwin's works. The Sky brought within Everybody's Reach was a clear, interesting, and at the same time scientific popular treatise on astronomy. He improved the favorable situation he enjoyed at Ross View for new observations of the zodiacal light, and, perceiving the advantages which a pure atmosphere afforded for his work, conceived and expressed the idea of seating observatories on the tops of mountains, which has since been carried out at several places, with all the good results he anticipated. He undertook in 1875 the preparation of a uranography, or map of all the heavens visible to the naked eye. In order to enlarge the field of his observations he spent a few weeks at Panama, and there, suffering from fever, contracted, in the service of science, the seeds of the disease that carried him off a dozen years later.

M. Lancaster thinks that Houzeau would have spent the rest of his days in Jamaica, if the death of Quetelet in 1874 had not prompted his recall to be the head of the observatory of Brussels. As it was, he found, when he returned to his home from Panama, a telegram announcing his appointment as director of this institution. The observatory had not of late years—Quetelet having been partly disabled by an apoplectic stroke suffered in 1855—kept up with the times. Its instruments had grown old-fashioned, and there was a lack of energy in its work. A commission was appointed after Quetelet's death to inquire what could be done to restore it. All agreed that a man of vigor was needed, and Houzeau's friends had no hesitation in asserting that he was the only Belgian who could supply the requisite faculties. But there was much against him. He had been long away, and was politically discredited and unorthodox. Even when his nomination had been put into the hands of the king for the royal signature, the ministers interposed objections. "He is a freethinker," they said. "That is a matter for his conscience," the king replied. "But he is a republican, too," they added. "That is my business," said Leopold, and wrote his name confirming the appointment. Even Rogier, who was responsible for Houzeau's dismissal in 1849, told the king that, if he were now minister, he would appoint him. "I owe him a reparation," he said.

Houzeau took charge of the observatory on the 17th of June, 1876. His views as to the renovation of the institution were approved. New instruments were obtained; the meteorological department was fitted up; a spectroscopic department was instituted; a daily meteorological bulletin was started, which he attended to personally for the first six months; popular lectures were instituted, the library was enlarged, new life was given to the publications, a catalogue was made of the astronomical and meteorological works in Belgian libraries; Ciel et Terre, one of the most valuable scientific periodicals of Europe, was begun, and vigorous activity was instituted in every department. During the six years that he remained here he published The Study of Nature, its Charms and its Dangers; his General Uranometry; an Elementary Treatise on Meteorology (with M. Lancaster), and special papers. In 1878, as Vice-President of the Geographical Society, he received Mr. Stanley on his return from his Congo expedition.

Houzeau revisited Jamaica, spending five months there, in 1878. In 1880 he was delegated as the Belgian representative in the Meteorological Congress at Rome, and visited Italy for the first time. In 1882 he led one of the two Belgian expeditions to America—one to Texas and the other to Chili—to observe the transit of Venus. Visiting San Antonio again, he gave lectures there on scientific subjects, and particularly on the transit. He had found the climate of Belgium too severe for his enfeebled constitution, and determined not to return there. He came back to France, and settled down for a year at Orthez, near Pau; then, wishing to be nearer to Brussels and to libraries while preparing his Astronomical Bibliography, removed to Blois. In November, 1883, he resigned his position in the observatory. His father dying in August, 1885, he resolved to return to his native land to take care of his mother, to whom he was always a dutiful son. The demands of his Astronomical Bibliography obliged him to go to Brussels, where his labors on that important work were varied by occupation with his Annuaire populaire, lectures for the geographical and microscopical societies and societies of art, and with writing articles on political and social economy for the journal Réforme; in addition to which he projected a great work on the Beginnings of Science. At the same time his health grew worse, and in the fall of 1887, while his general appearance was still not changed, he expressed to his friends the opinion that he would hardly live through the winter. He was confined to his bed in February, and died in July, 1888. He was buried, in accordance with his dying wish, in the most simple manner, in the public ground, with no stone to mark his grave. Nevertheless, a handsome monument, seven metres high, adorned on its four sides with appropriate astronomical and meteorological emblems, has been erected to him by the city of Mons, on one of its public squares, near the railway station, and was unveiled on the 2d of June, 1890, with addresses by the burgomaster of the city; M. Folie, Director of the Observatory; and M. Auguste Houzeau.

Most of Houzeau's principal works have been mentioned in the course of this sketch. His minor papers and special publications were very numerous, contributed to different societies and journals, and touched, as M. Lancaster well says, on nearly every branch of human activity. M. Lancaster's list gives eighty-six titles, counting as one matter contributed to the New Orleans Tribune enough to fill a dozen volumes. He was made a correspondent in the Class of Science in the Belgian Academy in 1854, and two years afterward a member of that body. He was a member of several other societies in Belgium, Holland, Luxemburg, London, and Vienna.

Mr. Wallace expresses the opinion, in his Darwinism, that animals are spared the pain we suffer in the anticipation of death, and that their lives are, therefore, lives of almost perpetual enjoyment; even the watchfulness they have to keep up against danger, and their flight from enemies, are, he believes, the pleasurable exercise of the powers and faculties they possess. Dr. R. W. Shufeldt, after many years of incessant study of animated forms of high and low degrees in the systematic scale, has come to very different conclusions from these. He believes that there has been as much evolution of mind, or reasoning powers, in animals as of organic structure; and that while the anticipation of death in the ordinary course has very little to do with marring the pleasures of life among men or animals, the immediate presence of death is awful to both. Instances are not wanting to prove that most of the higher animals appreciate the difference between a living and a dead body, and realize much of the suffering due to the fear of death as apart from the physical pain that may accompany it. In the case of flight from an enemy, or in the face of any other danger that may result in death, Dr. Shufeldt is convinced that the animal pursued, be it man or some of the vertebrated forms in the scale below him, experiences very much the same kind of sensations. Those who have studied timid animals under such circumstances "know full well that their pleasures in such flights are by no means unmixed ones, but are rather infused with a very large share of pain, and pain of a very high order."

CORRESPONDENCE.

"WHAT SHALL WE DO WITH THE DAGO?"

Editor Popular Science Monthly:

MR. APPLETON MORGAN'S query, in the Monthly for December, What shall we do with the "Dago"? suggests many other questions. I presume the writer did not design that his description of the "dago" should be regarded as typical of the Italian people, or of any considerable part of them, but only intended it to apply to a peculiar variety of the dangerous classes that happens to come from Italy; but his paper is, unfortunately, liable to the former offensive interpretation, and has, I happen to know, been taken in that sense in at least one quarter. Few will venture to dispute that Mr. Morgan's *lazzaroni* are as dangerous as he describes them; but it is hardly fair to regard them as the legitimate products of Italian nature. If we review the history of Italy, we shall find that it has been most conspicuous as the progenitor of a very different class of men.

Classes of outlaws, like the bandits and assassins of Italy, rarely appear prominently in any country that enjoys its own government. They are a result of foreign rule, under which even good citizens may come to regard the Government as their enemy. We do not find them in England, or France, or Germany, or Scandinavia, but in Ireland, in Hapsburg- and Bourbon-ruled Italy, and in the European countries under Turkish sway. If we regard them in Italy, we shall find them most prominent and dangerous in those states of the south that were longest and most continuously under Bourbon dynasties, as in Naples, or Austrian, as in the central states.

No European nation, excepting Greece, has done more for civilization and few for liberty than Italy. About twenty-six hundred and fifty years ago a band of natives emigrated from the "Long White Hill" in Latium and went to a group of hills on the Tiber and built them a new town. It would be a needless relation of a very old and universally known story to tell how Rome grew and conquered all the known world west of the Euphrates, tamed savages and squelched tyrants, and carried civilization to every quarter of its vast dominions; to describe the buildings it erected, the cities it founded, and the roads it constructed; to name its long roll of illustrious men—warriors, statesmen, popular tribunes, orators, artists, and authors; its more illustrious women, typifying all that is best in the sex; or to speak of its laws, the principles of which lie at the foundation of most of the European codes. These men, the authors of these great works, mostly came from the same stock as Mr. Morgan's "dagoes"; for, as fast as one set of great men or noble families died out, others rose or were promoted from the ranks. Rome has been called and is called the "Eternal City." It has always, since two centuries before Christ, been the source of the strongest influences by which the world has been ruled. "Roman virtue," "Roman honor," and "Roman firmness" are living proverbs.

After the Western Roman Empire was destroyed and Europe was subjected to barbarian despots, there were still free republics, civilization, and literature in Italy. These republics lasted till they were overthrown by foreigners, some holding out till the beginning of this century. Communication was kept up with the Greeks at Constantinople, and the light of literature and art shone in Italy through all the darkest of the dark ages. The history of these republics is full of brilliant deeds and illuminated by the names of men distinguished in various lines, and heroes, the details of whose history are now hard to find, but of which the mere references in Dante's poem furnish a long catalogue.

Considerations of space forbid more than a mere reference to the splendor of Italian achievements in literature and art from Dante's time till the fifteenth and sixteenth centuries. The story is familiar. The history of the world affords but one parallel to it—Greece in the age of Pericles.

Four hundred years ago there was an Italian who made himself a great nuisance. He had conceived the idea that, if he should sail west on the Atlantic, he would find something worth going after. He bothered the Pope and he bothered the King and Queen of Spain till they were distracted to know what to do with him; and Ferdinand and Isabella at last gave him ships as the easiest way to get rid of him. We are inviting all the world to come over here two years hence to help us do his memory the highest honors in our power; and there is a rivalry between us and Spain as to which shall give him the greatest honor.

Another Italian—he was born in Corsica—although he was no doubt a bad man, about the beginning of this century struck the blows which resulted at last in freeing Europe from the despotisms and the doctrines of despotism which had cursed it for a thousand years.

How will it be possible, in less than a volume, to do justice to what the Italians have done in the last forty-five years for the freedom of their country and for human liberty? At the beginning of this period Italy was, as Talleyrand had said, with a sneer which was also truth, only "a geographical expression." It was divided up among some dozen or twenty foreign sovereigns, some of whom were of very low degree, and all used their power for dynastic ends only, regardless of the sufferings of the people. This was and had been for centuries just the condition to breed *lazzaroni* and bandits. One sovereign away up in the northwest, a man of the country, had ideas beyond his family, and thought of the people. With him and his son Victor Emanuel as chiefs, and the great native hero to urge them on and compel them when they would not be persuaded, and Cavour to organize, the long battle was fought of the people of Italy against the world. The people of Italy triumphed and founded a kingdom than which no modern state is more enlightened or progressive. This great work of persistent heroism and its crowning success are the achievement of the common people of the country—the "dagoes"—and no one else, with no help except what they compelled. Its champions, Victor Emanuel, Garibaldi—whom Mr. Morgan's "dagoes" in person resident in America have honored with a creditable bronze statue—Cavour, and their associates, are counted to-day among the world's noblest men. We might speak of Italian music and of Italy's contemporary literature and science, which occupy no mean position, but we have said enough. What shall we do with the dago? Give him a chance.

W. H. Larrabee.

Plainfield, N. J., *December* 10, 1890.

EDITOR'S TABLE.

RELIGIOUS TEACHING IN THE PUBLIC SCHOOLS.

FOR good or for evil, education is now very generally regarded as a function of the state, and has, in point of fact, been assumed by the state to such an extent that private enterprise in the matter of education is reduced to an altogether secondary *rôle*. One drawback to this is that questions of school management have now become, in the main, questions of politics. When we ask, "What should the schools teach?" we mean, as a general thing, "What, as parties and votes are balanced, is it practically possible and desirable for the schools to teach?" We are strongly of the opinion, for our own part, that this is not a satisfactory position of the question. Had education been left untrammeled by state interference, we should have had many different types of schools, and many different experiments made by different teachers. Instead of discussing the question as to what the schools should teach in a good deal the same way as a political convention would canvass the merits of rival candidates, we should content ourselves with noting what the schools were teaching, and with laboring individually to bring this or that special conviction of our own on the subject of education into practical recognition. Under the present system we do not inquire what makes or would make for full intellectual and moral development, but merely what courses of study will be free from objection on the part of this, that, or the other section of the electorate. This is part of the price we pay for state education.

Well, there is nothing to do but to make the best of things as they are, and it was perhaps a wise thing on the part of the Presbyterian Synod of New York to summon a conference of representatives of the different Protestant churches to discuss the question as to the extent to which religious instruction might and should be imparted in the public schools, regard being had to all the circumstances of the case. Now that the conference is over, it is sufficiently evident that the views of those who would introduce more or less of theological doctrine into the schools can not prevail. They can not prevail, simply because the conditions necessary to their success are absent. "The stars in their courses fought against Sisera," and the stars in their courses, or at least the influences of the time, are fighting against those who would make the state the teacher of any system of theological doctrines however elementary or fundamental whatsoever. The most striking address delivered in support of religious teaching was that of Dr. William A. Butler, who took up the position that, while in this country there is an absolute divorce between church and state, there never has been any divorce "between Christianity and the state, or between the state government in its administration and the Christian religion, as revealed in the Scriptures." The inference which the speaker drew was that it was entirely lawful and proper for the state to sanction "the reading of the Scriptures in the public schools, without note or comment, as also the use of the Lord's prayer, and the inculcation, under proper safeguards, without admixture of human doctrine, of Christian morals."

This view of the case was vigorously combated by Dr. Ward, editor of The Independent; and, we must confess, it seems to us amazingly weak. Far be it from us to argue against religious teaching in schools under private control, or to assert or imply that the religious element is not a most important one in education generally. That was not the question before the conference, nor is it one with which we should think it right to concern ourselves. The question is, Can the state teach religion? Dr. Butler thinks it can, because there has never been any divorce between the state and Christianity. The reason is glaringly insufficient. A "divorce" means a tearing asunder; there has been no divorce between the state and Christianity for the excellent reason that there never was any union of a formal or legal kind to sever. A majority of the population, it may be assumed, are professed adherents of Christianity, but it does not follow from that that they have authorized the Government to give effect in any practical shape to such convictions as they may have on the subject. Before the Government can act, it must have a very clear mandate; and manifestly the people could not give the Government a mandate on this subject without stating clearly what they understood by Christianity, and with what degree of detail they wished its doctrines to be made matter of instruction in the schools. The idea of a government deciding such questions for itself is simply ridiculous. In certain cases, where technical knowledge is required, the state can call experts to its aid—architects, engineers, chemists, electricians; but imagine for a moment the Government calling for expert assistance in a question of theology! But to come down to facts, the people do not want the state to undertake any theological or religious business on their behalf. They know, they deeply feel, its utter incompetency in that sphere. They know that it is as much as they themselves can do in their several churches to avoid causes of dispute and separation; and they have not the most remote idea of inviting the politicians whom they have elected to office to make amateur theologians of themselves for any purpose whatsoever. The very idea is so incongruous with the spirit of the time that it is hardly worth while to insist on the fact that the Christian community is itself divided by the most serious differences of opinion upon various theological questions—so much so that, in the eyes of certain Christians, others who claim the name have no title to it whatever. The differences of opinion, for example, between Trinitarians and Unitarians, and between Universalists, who look forward to the salvation of all, and those who, as the Scotch woman said, "hope for better things," or between Roman Catholics and those who think that Roman Catholicism is "the beast" of the book of Revelation and the Papacy the "scarlet woman," are fundamental, and any religious teaching that was meant to gain equal approval from these and all other sections of the Christian community would have to be very vague and non-committal indeed. The whole merit and force of a religious system consist in its teaching authoritatively that which would not otherwise be conveyed to the mind at all; while the essential character of any religious instruction which the state could give would be found in its vagueness and conventionality.

Well, therefore, did the Rev. Dr. W. H. Ward declare that "we may consider it as settled that religion is not to be taught in the public schools—that the American people will not trust the state to teach religion." Manifestly, to give a thing in a weak and diluted form which, to have any virtue, must be given in a strong and concentrated form, is to do more harm than good; and it may safely be said that, if through unwise legislation the formal teaching of religion were begun in the schools by such agencies as the state can command, the result would be disastrous to the cause of religion itself. Dr. Ward took what probably most of his hearers must have regarded as an extreme and dangerous position when he said that "morals do not depend on God"; but, as he meant it, we do not doubt that he expressed a truth. His meaning we take to be that the principles of morality are as capable of formulation without the help even of the theistic hypothesis as those of any other subject of human study. What, after all, are our ideas of God but the highest ideas which our human experience has enabled us to frame? There is no difficulty, then, in teaching morals in the schools without theology—no difficulty, that is to say, in laying down the rules of right conduct as a thing to be practiced here and now for reasons of present validity. But, as Dr. Ward judiciously observed, the best moral teaching will result from the observance of order and discipline, honor and justice, in the management of the school itself. Direct preaching is of doubtful utility; but example tells, and facts are powerful persuaders.

It is possible the late conference may lead some to perceive, as they never did before, the disadvantages connected with making education a branch of politics. In discussing education we should not have to canvass a political situation, but at present that is just what we have to do. And when we engage teachers for our public schools we engage them to follow a prescribed routine, not to throw all their original force and all their deepest convictions into their work. That the highest type of education is not to be had on this plan is evident; and whether the wider diffusion of education, due to state agency, is sufficient to make up for the deterioration in the quality of the article is a most serious question, which we believe the experience of each succeeding year will force more and more on the attention of the community.

INTERNATIONAL COPYRIGHT.

Every day is adding to the number of those who believe that ethical standards are the safest guides in the conduct of men's affairs. All such will find good reason to rejoice at the evidence of a dawning conscience in political circles afforded by the recent passage of the copyright bill in the House of Representatives. For nearly a century those citizens of the United States who believed in honest government have been more or less actively striving to obtain for the foreign author some sort of effective recognition of the principle embodied in this measure. Property in ideas, when these have been materialized in the form of books, has long been practically recognized, as well in the copyright laws of our own as in those of other countries. Yet for years, and in the face of this fact, we have suffered the disgrace of being about the only civilized nation on earth mean enough to refuse to make the principle international in its application. Whenever it was proposed to do this, the enemies of the reform have raised the cry of "expediency," "the needs of the reading public," "the advantages of cheap literature," and other similar catch-words intended to mislead, while the ethical questions involved have been contemptuously brushed aside as unworthy of serious notice.

By its refusal to legislate on the subject in accordance with well-known principles in force in other countries, our Government, it is not unfair to say, tacitly maintained that, after all, stealing was quite the thing, or at least not to be interfered with, as long as it served the interests of a numerous class, and could be carried on without peril and to the profit of the thief. To plunder the foreign author became an innocent occupation: he was not one of us, and we stilled our consciences with the pretense that moral obligations were limited by geographical boundaries.

The decisive majority in favor of the new bill sharply discredits this belittling view of our duty as a nation. It also marks a most encouraging advance in public sentiment which is daily growing more and more appreciative of that rare variety of legislation which is founded on right and justice. There is good ground to hope that the bill will meet with equal success in the Senate, while the President, with his well-known devotion to principle, is already committed in its favor.

Yet, bright as the prospects for the early triumph of the measure appear to be, its friends and promoters can not afford to relax their efforts until the bill becomes a law Signs are not wanting that its enemies, so far from being discouraged by the present attitude of Congress, have rather been stimulated by it to renewed exertions in their desperate opposition to the reform. They are trying to create dissensions among its supporters, hoping by this means to weaken their influence in its behalf.

In view of this it should be remembered that few measures of the kind can be perfected until they have had a practical trial. It would be the height of folly to imperil the essential principle of the bill merely because some of its minor details did not exactly meet the views of all its supporters. The greatest need now is, that those more directly interested in the welfare of the measure should sink their differences, and, uniting with the friends of justice and honest legislation everywhere, should continue to urge the matter upon the attention of Congress until success has been achieved, trusting to time and experience, when need arises, to bring the several features of the law into closer harmony with the public interest.

LITERARY NOTICES.

Outings at Odd Times. By Charles C. Abbott, M. D. New York: D. Appleton & Co. Pp. 282. Price, $1.50.

It is a pleasant task to review one of Dr. Abbott's books. The contrast implied in the title of his preface to this volume—"Nature and Books about it"—is reduced to the lowest point in his writings. The genial doctor has a happy faculty for transferring the charm of Nature to the printed page, that is the more valuable for its rarity. It might seem a mistake on the part of the author to put as the first of his four groups of essays the one headed "In Winter," for Nature in that season is by many regarded as wholly uncommunicative, if not frigidly forbidding. But Dr. Abbott does not find it so. Coming to an ice-fringed brook, in one of his winter outings, he quickly detects in the water "dainty little frogs—the peeping hylodes—squatted on dead leaves and yellow pebbles, and so spotted, splotched, and wrinkled were they that it took sharp eyes to find them. . . . The spirit of exploration seized me now," he says, "and I brushed the shallow waters with a cedar branch. Lazy mud minnows were whipped from their retreats, and a beautiful red salamander that I sent whizzing through the air wriggled among the brown leaves upon the ground. It was only after a hard chase that I captured it, and, holding it in my hand until rested, I endeavored to induce it to squeak, for it is one of a very few that has a voice; but it was not to be coaxed. It suffered many indignities in silence, and so shamed me by its patience that I gently placed it in the brook. Soon black, shining whirligigs—the gyrinus—suddenly appeared; and a turtle, as if wondering what might be the cause of the commotion, thrust its head in the air, stared angrily at me, and returned to its hidden home. There was no dearth of life in the brook, yet this is a winter day." Equally numerous does he find the birds in winter, and, in the right places, growing plants, with an occasional flower, if the season happens to be open. He sees, too, the meadow mice, skurrying back and forth in their grass-walled, ice-roofed runways. In spring, Nature's drama becomes more varied. Under the name of this season, Dr. Abbott discourses of the April moon, of small owls, of apple blossoms, etc., and even draws entertainment from such an unpromising place as a meadow mud-hole. In summer, and again in autumn, the scene changes, but all under such delightful leadership is intensely fascinating. Sprinkled through these pages are bits of reminiscence of boy life, not without its pranks, in a Quaker farmer's family; and digressions upon such topics as old almanacs, weathercocks, "skeleton-lifting," and fossil man in the Delaware Valley, occur here and there. The material form of the volume, with its narrow page and wide margins, and its tastefully designed cover, admirably fits the character of the matter within.

The Pre-Columbian Discovery of America by the Northmen, with Translations from the Icelandic Sagas. By B. F. De Costa. Albany, N. Y.: Joel Munson's Sons. Pp. 196. Price, $3.

A scholarly and entertaining work is this upon the Northmen and their Western voyages. The author was doubtless instrumental in arousing interest in regard to the Icelandic chronicles and literature by the publication of the first edition of this book in 1870, and he must view with satisfaction the progress made since that time, which has been emphasized in the erection of two statues to Leif Ericsson.

Fairly and candidly the author treats all evidence bearing upon the earliest knowledge of the American continent, even admitting that many facts point toward the Irish as the first to cross the Atlantic. Beginning with references found in Greek and Latin authors to "a vast island lying far in the West and peopled by strange races," he comments upon the exploits of Tyrian and Phœnician navigators. Cadiz, in Spain, was settled by Tyrian traders 1200 B. C.; in the ninth century there were colonies upon the western coast of Africa; and three hundred years later the continent was circumnavigated by the Phœnicians. A chart of the Canary Isles was made by Sebosus, 63 B. C., and a description of King Juba's expedition is furnished by Pliny. It is regarded as a possibility that the Phœnicians made transatlantic discoveries: "From the Canaries to the coast of Florida is a short voyage, and the bold sailors of the Mediterranean, after touching at the Canaries, need only spread their sails before the steady-breathing monsoon, to find themselves wafted safely to the western shore."

The first chronicle of any voyage to America is found in the Icelandic tongue. This language was spoken by the Northmen who settled in Denmark and the Scandinavian countries, but were at length oppressed in Norway by King Harold. Too proud to brook any curtailment of their power, the jarls sailed away to the frozen shores of Iceland. Here, in 868, they found Christian monks who would not affiliate with the pagan new-comers, but promptly gave up their icy retreat and "left behind them Irish books, bells, and croziers, from which it could be seen that they were Irishmen." In 982 Eric the Red, banished from Iceland, sought refuge in Greenland. Colonies were soon established here, and only eight years elapsed before Leif, the son of Eric, made his first voyage to Vinland. The Ericssons were a family of explorers. Thorvald and Thorstein, brothers of Leif, and Freydis, a sister, each undertook an expedition to the new land. The most important voyage was made by Thorfinn Karlsefne, an Icelander of famous lineage, who, with three vessels and one hundred and sixty men, visited Vinland and remained three years. Had it not been for the observant habits of the Icelanders, who were taught to study "the divisions of time and movements of the heavenly bodies," the location of Vinland might be a matter of doubt; but it is fixed not only by their description of the coast and character of the country, but by the account of Leif and his comrades, that "on the shortest day the sun was in the sky between Eyktarstad and Dagmalastad," periods corresponding to 4.30 P. M and half-past 7 A. M., making the latitude 41° 43′ 10″, nearly that of Mount Hope Bay. Ancient vessels that have been exhumed in Denmark, as well as measurements found in the Sagas, prove that the ships of the Northmen were able to bear them across the Atlantic. That no enduring structure marks their occupation of New England is not astonishing; according to the story of their sojourn, they lived in wooden booths.

The literature and general knowledge of the Icelanders were much in advance of the rest of Europe during the twelfth century, so that it is altogether credible that they wrote the Sagas and performed the voyages recorded. A corroboration of the Icelandic writings is also found in early English annals, which contain statements and dates that exactly agree. The manuscript from which the Sagas are taken is the Codex Flatöensis, "a work that was finished in 1395 at the latest, . . . and now preserved in the archives of Copenhagen."

The latter part of Dr. De Costa's work is devoted to translations from these writings, relative to the pre-Columbian voyages. Extracts are given from the Landanama, the doomsday-book of Iceland; from the Sagas of Eric, composed in Greenland; and from the Saga of Thorfinn, of Icelandic origin. Following these are minor narratives taken from the Eyrbyggia Saga, and two geographical fragments that mention Vinland. Although the volume possesses an index, it has the unusual distinction of being a book without chapters.

Dust and its Dangers. By T. Mitchell Prudden, M. D. New York: G. P. Putnam's Sons. Pp. 111. Price, 75 cents.

The author of this book does not discuss purely inorganic dust of any sort, not even the specially injurious kinds resulting from processes of manufacture, but in a simple and attractive way tells of the common dust that is dangerous — that which contains micro-organisms hurtful to man. He describes the classes of germs that can be identified, and explains how biological analyses of the air are made by the "filtration" and the easier "plate method." Comparison of averages obtained in various cities and in different localities in New York show that the number of bacteria in a given volume of air varies chiefly according to condition, the process of street-cleaning summoning the greatest number of germs, 5,810 to a disk 3⅞ inches in diameter. Indoor air is, however, the main subject of investigation, and experiments prove that ventilation which completely changes the atmosphere three times an hour will not appreciably affect the number of bacteria in an apartment, as the intruders cling obstinately to the carpets and upholstery. Only violent currents of air dislodge these, and the sweeping and cleansing which result in removing, not redistributing the dust. Ordinarily we are liable to take in with every twenty breaths from eleven to eight hundred and seventy-six organisms.

Among the disease-breeding bacteria Dr. Prudden selects for study the one numbering most victims, the *Bacillus tuberculosis*. He points out that prolonged drying does not kill it; that it does not exist in the air exhaled from consumptive lungs, but in the sputa that is ignorantly allowed to become part of the dust. It results that "the way to most efficiently stop this distinctly preventable disease is to see that the sputum of consumptives is properly disposed of."

One of the most instructive chapters is that in which the action of the cilia, of the lymph-filters, and of the wandering white cells, is described. A number of illustrations and an index accompany the book, which is published in uniform style with The Story of the Bacteria, by the same author.

Races and Peoples. By Daniel G. Brinton, M. D. New York: N. D. C. Hodges. Pp. 513. Price, $1.75.

A series of lectures, delivered at the Academy of Natural Sciences, in Philadelphia, during the early months of 1890, forms the basis of this book. In the first two lectures are given respectively the physical and the mental characteristics of races, upon which ethnography is based. The third lecture discusses the beginnings and subdivisions of races, locating the birthplace of the species in a region comprising southern Europe, the bed of the Mediterranean, and northern Africa, which in early Quaternary times was one connected body of land. In succeeding chapters the probable course of the early migrations of the various races, and the formation of subdivisions, are traced. The author places the first home of the white race—which he calls Eurafrican—in the region just mentioned, and regards its migrations as having taken place toward the east in two divisions. The early history of the black and yellow races, and of certain insular and littoral peoples, is then taken up. In his review of the American race, Dr. Brinton does not take up the question where the Indians came from, having stated fully elsewhere his reasons for believing that America was peopled from Europe, by way of a former land connection across the north Atlantic. A concluding lecture is devoted to discussing the destiny of races, and certain ethnographic problems, as acclimation, amalgamation, and civilization. An index of authors quoted and one of subjects are appended.

Our Government: How it grew, what it does, and how it does it. By Jesse Macy, A. M., Professor of Constitutional History and Political Economy in Iowa College. Revised edition. Boston: Ginn & Co. Pp. xii + 296.

Prof. Macy is to be congratulated on having produced in the work above mentioned an extremely valuable treatise upon the system of government under which we live. One of the encouraging signs of the times is the attention which is beginning to be bestowed in our schools and colleges upon the laws and institutions of the land—upon American politics in the wider and better sense. Foreigners are under a general impression that all American citizens able to read and write have the Constitution of their country at their fingers' ends, and that no one here needs much special preparation to enter on a political career. We could wish the impression had more foundation in truth than it has. The fact is, that ignorance in regard to the whole field of political knowledge is wide-spread among the electorate, and is in danger of becoming more so from year to year. The efforts, therefore, that are now being put forth to foster such knowledge are most timely; and we welcome the appearance of a manual like the present, which brings home to the mind of the student or general reader what kind of a country this is in a political sense; what the rights and duties of each citizen are, and what powers and responsibilities are invested in the different grades or species of government by law established. There are great advantages in a healthy and vigorous development of local institutions as with us; but, as everything good has some drawback, so this, on the whole, fortunate circumstance has the drawback of somewhat enfeebling the individual citizen's consciousness of participation in the life of the nation. We need to awaken and stimulate this consciousness, and the way to do it is undoubtedly to bring the facts of national life home to each mind by careful instruction. We do not hesitate to say that a knowledge of the facts contained in the work before us could scarcely fail to create in any ordinary mind a respectful interest in national and State politics, and would thus tend to rescue the individual citizen and voter from the hands of mere intriguing party managers. The amount of information in regard to local, municipal, State, and Federal Government that Prof. Macy has managed to pack into the present manual is surprising. There is not a single page which any student who desires to be thoroughly well informed in United States politics can afford to skip. Comparing the present work with Mr. Fiske's recent book, we may say that Prof. Macy's is the more complete hand-book of the two, while Mr. Fiske's is perhaps better adapted to bring home powerfully to the mind of the reader a limited number of carefully chosen facts and ideas. A valuable division of Prof. Macy's book is Part III, on The Administration of Justice, in which a large amount of information is given in regard to State and Federal courts and their respective jurisdictions and modes of procedure. The different departments of the Federal Government are well described in Part IV, as well as the methods followed by the two Houses of Congress in the dispatch of business. Part V deals particularly with Constitutions—chiefly, of course, State and Federal. The idea that may be derived from the *résumé* of State Constitutions here given is that much might yet be done to bring some of these into a more rational and business-like form. We are strongly reminded how many things with us are yet in the experimental stage, and the thought is not very far in the background that much of our experimenting has been somewhat crudely done.

Prof. Macy has abstained from all criticism of institutions. Even in pointing out the differences between British cabinet government and the system established here, he does not venture on any hint as to which on the whole is the better, or as to which is the better even from any partial point of view. He does not hesitate, however, to condemn the "spoils system," giving in detail his reasons for regarding it as one of the plague-spots of our political life. We think that perhaps a few words more than he has actually given might have been devoted to the Civil-Service Bill at present in force; and it might not have been amiss to show how difficult both political parties seem to find it to carry out their pledges in favor of civil-service reform. Take it all in all, however, as a hand-book of the political institutions of the United States, Prof. Macy's little work is deserving of high praise for completeness, accuracy, and good sense. We hope it will come into wide use.

A Manual of Public Health. By A. Wynter Blyth, M. R. C. S., etc. London and New York: Macmillan & Co. Pp. 653. Price, $5.25.

This work is a comprehensive and authoritative text-book for officers of public health departments. Its first section, of three chapters, is devoted to vital statistics, giving methods of recording the data, and of calculating birth and death rates, life tables, etc., and describing certain calculating machines. The next section deals with air, ventilation, and warming, taking up the general character of air, with methods of analyzing it, the principles and methods of ventilating and warming, and including a chapter on measuring cubic space and reporting on ventilation. Two short chapters describe the common instruments used for meteorological observations. A section on water supply tells the usual sources of water, and gives microscopical, biological, and both qualitative and quantitative chemical processes for water analysis. There is also a chapter describing the supplies of the various companies furnishing water in the city of London. The section on sewerage describes the construction of house drains and of sewers, the arrangements for certain special systems of sewerage, and various methods for the disposal of sewage. The sewering of London is also described, with a map. Under the head of nuisances, the processes employed in a large number of manufactures yielding offensive waste products are given.

The section on disinfecting contains experimental methods for testing the value of a disinfectant, an account of various apparatuses for disinfection by heat and of the general process, and information concerning chemical disinfectants, giving especial prominence to the halogens. About two hundred pages are devoted to zymotic diseases, in which the modern general theory of micro-parasites is first given, and then the special character and course of each disease of this class. Single chapters deal with the construction of isolation hospitals, the general principles of diet, and the duties of sanitary officers as prescribed by English statutes. Inspection of food is the subject of the closing section, and this gives the characteristics of unfit vegetable and animal foods, and describes diseases of animals which make their flesh unwholesome. There are sixty-five cuts and plates, and an index.

English Fairy Tales. Collected by Joseph Jacobs, Editor of Folk-Lore. New York: G. P. Putnam's Sons. Pp. 253.

"Who," the editor asks, "says that English folk have no fairy tales of their own? The present volume contains only a selection out of some one hundred and forty, of which I have found traces in this country [England]. It is probable that many more exist." A quarter of the tales in the volume have been collected during the last ten years or so, and some of them have not been hitherto published. The name Fairy Tales is given to the collection, though few of the stories speak of fairies. Yet they are what the little ones mean when they call for fairy tales. They do not call for "folk tales" or "nursery tales," and this is the only name we can give them. The term fairy tales must be extended a little to include tales in which something "fairy," or extraordinary, like fairies, giants, dwarfs, or speaking animals, occurs; and also to cover tales in which the extraordinary thing is the stupidity of some of the actors. The question of nationality, too, is one to which it is hard to assign limits. Some of the stories were found among the descendants of English immigrants in America, some in Australia, some among the Lowland Scotch; and one of the best was taken down from the mouth of an English gypsy. Some of them exist in the form of ballads. Writing for children, the author has considered it expedient to take a few liberties with the text, translating sometimes from dialect or introducing or changing an incident; but mention of the fact is always made in the notes. He has felt authorized to do this amount of adaptation because he expects on some future occasion to treat the subject of the English folk-lore tale in a critical manner, when the originals will be reproduced with literal accuracy.

The Myology of the Raven. By R. W. Shufeldt. London and New York: Macmillan & Co. Pp. 343. Price, $4.

The author has prepared this treatise in the belief that a work fully and practically illustrated and devoted to a complete account of the muscles of any species of bird is wanting; and that such a work would be of service to persons engaged in the general morphology of vertebrates as well as to special students. Birds are among the most easily procurable subjects for the use of the demonstrator and the student, and of these none are more convenient than those of the raven kind, which represent a numerous and cosmopolitan family, including the crows, jays, orioles, and very many others. As, according to the author, the student's investigations in the myology of birds advance, three lines of improvement in knowledge of their muscular system will force themselves upon him. "In the first place, we still remain very ignorant of the details of this system in a great many important types of birds; secondly, an ever-pressing demand is evident to fix the homologies of muscles in the vertebrata, and, consequently, to bring so far-reaching a knowledge of this department of research to our assistance as to be able to give the same name to the same muscles accurately throughout the vertebrate series; and, finally, a simple, scientific, and euphonious nomenclature is very much to be desired. As an index of our present status with respect to our knowledge of the muscles of birds, it is hoped that the volume here offered will faithfully represent it; but its writer trusts that in future works he may lend his assistance to the improvement of all the lines above indicated."

A Practical Delsarte Primer. By Mrs. Anna Randall-Diehl. Syracuse, N. Y.: C. W. Bardeen. Pp. 66.

If the only aim of this little book had been to serve as a guide in making the body flexible and responsive, one third of the contents might have been omitted with nothing to regret.

The first chapter suggests an excellent drill to gain bodily control. Exercises are given for the fingers, hands, shoulders, head, and trunk; also directions for various movements, including stage-falls. In the closing chapter it is shown how the acquired suppleness may be utilized in representing mental and emotional states. The laws of expression in relation to each organ are defined, and a quotation is made from Duchenne's Human Physiognomy, confirming the method delineated.

The intermediate part of the book is taken up with an outline of the philosophy of Delsarte, which is said to depend upon "the triune nature of man." A trinity is defined as "the union of three things necessarily coexistent in time, copenetrative in space, co-operative in motion." Accordingly, the human organization is split up into ternary combinations, and nothing is allowed to overflow the trinitarian mold. There is the "essential trinity" and the "dynamic trinity"; the "nervous," the "circulatory," and the "visceral trinity."

The triple classification into moral, mental, and vital, differentiates our unoffending members in a remarkable manner. The bones are vital, the skin mental, and the flesh moral. The pupil of the eye expresses intellect, but the iris has a leaning toward righteousness. The tip of the nose is also virtuously distinguished from the nostrils.

Why the epigastric organs should be moral while the thoracic are mental is another philosophic mystery.

Not less perplexing than this tripartition is the use made of the word thermometer. We learn that there are six physical thermometers—the larynx, wrist, shoulder, elbow, eyebrow, and thumb. The eyebrow is the thermometer of the mind, from which we might infer that Shakespeare wrote in all seriousness of "a woful ballad" to that important feature. However, judgment is declared to be "the lowest form of intellectuality," and in the dim light above it, or without it, little incongruities, such as have been noticed, may not appear.

In a sketch of François Delsarte, prefixed to this work, it is expressly stated that he died in 1871. Were it not for this, we might conclude that he flourished some seven hundred years earlier, and that we had stumbled upon a manual of the old scholastics, who tortured facts into accordance with arbitrary symbols and "ground the air in metaphysic mills."

Are the Effects of Use and Disuse inherited? By William P. Ball. Nature Series. London and New York: Macmillan & Co. Pp. 156. Price, $1.

This is obviously and avowedly a controversial book. The author takes the negative side of his question, in opposition to Darwin and Spencer, and argues it with much ability and in an admirably courteous tone. He is not, however, alone in his position, for he is able to name Weismann, Wallace, Poulton, Ray Lankester, and Francis Galton as disagreeing in greater or less measure from the two great leaders just named. The author examines in detail the examples of Spencer and those of Darwin cited on the affirmative side of this question and replies to them. He next discusses the inheritance of injuries, and then passes to certain miscellaneous considerations. In conclusion, he affirms that use-inheritance is supported by insufficient evidence, while "the adverse facts and considerations are almost strong enough to prove the actual non-existence of such a law or tendency." But, he says, "It will be enough to ask that the Lamarckian factor of use-inheritance shall be removed from the category of accredited factors of evolution to that of unnecessary and improbable hypotheses. The main explanation or source of the fallacy may be found in the fact that natural selection frequently imitates some of the more obvious effects of use and disuse. . . . As depicted by its defenders, use-inheritance transmits evils far more powerfully and promptly than benefits." It is to natural selection, without the doubtful aid (as he deems it) of use-inheritance, that he trusts to save the race as a whole from degeneration.

Astronomy: Sun, Moon, Stars, etc. By William Durham, F. R. S. E. Edinburgh: Adam & Charles Black. Pp. 133. Price, 50 cents.

The character of this book is indicated by the name of the series in which it is the second volume—Science in Plain Language. The author states that it is not a treatise on astronomy, but that it "merely describes in plain language some of the more interesting facts and speculations connected with that science." The divisions of the subject which he makes are, the sun and moon; the earth; stars, nebulæ, etc.; planets; astronomical speculations as to the formation of the heavenly bodies, and the contents of space; the tides, etc. The various topics are treated in an attractive style, free from mathematics, but in such a way as to impart as full a knowledge of astronomy as most cultivated people require.

Derivation of Practical Electrical Units. By Lieutenant F. B. Badt and Prof. H. S. Carhart. Chicago: Electrician Publishing Company. Pp. 56. Price, 75 cents.

How did certain electrical units come to be called ampère, ohm, farad, etc.? must have been asked by many persons, knowing more or less of electrical science. To answer this question is the task that Mr. Badt undertakes in the little volume before us. He gives in an introductory chapter the general reasons for adopting the system of practical units now in use, with a table showing the names and symbols of the several units, the quantity to be measured by each, comparative values, remarks, etc. This is followed by biographical sketches and portraits of the eminent electricians whose names have been given to these units. The list includes

Weber, Gauss, Ampère, Volta, Ohm, Faraday, Watt, Joule, Dr. Werner von Siemens, Sir William Siemens, Daniell, and Von Jacobi. A sketch of Coulomb is also given, without a portrait, and the author doubts if one is extant. In each sketch is told how and when the name of the subject was adopted for an electrical unit. A chapter by Prof. H. S. Carhart on Modifications of the Practical Electrical Units, is added, in which it is pointed out that, since there are three units of resistance in use, there are accordingly three modifications of all units depending upon this.

Psychological investigators will be interested in Prof. *Joseph Jastrow's* essay on *The Time-Relations of Mental Phenomena*, published in the series of Fact and Theory Papers (Hodges, 50 cents). The paper defines and analyzes simple and complex reactions, describes the methods of experimentation that have been devised by a number of investigators, and gives two tables—one of simple, the other of complex reaction times—from the observations of Cattell, Berger, Münsterberg, Kries and Auerbach, Merkel, and others. Various conditions affecting the times of simple reactions, and such as affect distinction, choice, association, and other elements of complex reactions, are discussed, and a classified bibliography is appended.

A little manual on *Maps and Map-Drawing*, by *William A. Elderton*, has been issued in Macmillan's Geographical Series (Macmillan, 35 cents). It describes briefly various modes of surveying, and tells some of the things that can be learned from globes—among them the explanation of great-circle sailing. In the chapter on map-drawing the several projections are described; contouring, hachuring, and mezzotint shading are taken up; and a few directions for the use of maps are given. A short chapter on copying maps is included; but the author does not deem this as important as the drawing of memory maps. The latter subject he, accordingly, treats more fully, giving directions for drawing a memory map roughly, taking France as an example; also for doing more careful work, using England and Wales as the subject; and for a rough map of the world on Mercator's projection.

An address on *The Future of Agriculture in the United States*, by Dr. *Peter Collier*, of the New York Agricultural Experiment Station, is devoted to the exhortation of farmers to study and put more intelligence into their work, and to the enforcement of the thesis that "we have not yet begun to approach the limit of even profitable production upon our lands."

A new monthly periodical, called the *Educational Review*, is to be begun in January, to be published by Henry Holt & Co. Prof. *Nicholas Murray Butler*, of Columbia College, President of the New York College for the Training of Teachers, will be its editor, and will have as his associates head-master E. H. Cook, of Rutgers Preparatory School, New Brunswick, N. J.; Dr. William H. Maxwell and Dr. A. B. Poland, superintendents of schools in Brooklyn and in Jersey City. The University, the Preparatory School, and the public schools will thus be represented in its editing. The enterprise starts with the approval, attached to its prospectus, of some hundred leading educators.

Poet Lore, a monthly magazine, devoted to Shakespeare, Browning, and the comparative study of literature (Poet Lore Co., 1602 Chestnut Street, Philadelphia), *Charlotte Porter* and *Helen A. Clarke*, editors, is a literary periodical of the highest order. Besides the two authors specially named, recent numbers have contained studies of the Provençal poets, by Miss M. L. Elmendorf; English and German Literature in the Eighteenth Century, by Prof. Oswald Leidensticker; Shelley; the Alkestis; Dante; The Russian Drama, by Nathan Haskel Dole; and other papers, which define the scope of the publication as a sufficiently broad one to make it acceptable to all cultivated readers. The November number contains a study of Browning's "Childe Roland." Next year, in lieu of the July and August numbers, double numbers will be published in June and September, each containing a foreign work of the first order, little known, but destined to awaken strong interest. The contents will be increasingly in the direction of comparative criticism. Price, 25 cents a number; $2.50 a year.

G. P. Putnam's Sons publish, in the Story of the Nations Series, *Switzerland*, prepared by Lina Hug and Richard Stead. Due stress is laid upon the interest of the story, which is attractive to American readers by its association with the other features of the country—"the playground of Europe"—as well as by the long, arduous, and faithful struggles for liberty which it records. Most of the existing accounts of Swiss history in the English language go no further back than A. D. 1291, the date of the earliest Swiss league, and of the beginning of modern Swiss nationality. The authors in the present volume have gone beyond this, and have included the previous history of the men who founded the league, with the changes which the country has undergone, in being overrun by different barbarous tribes; accounts of Cæsar's Helvetians; and of the lake-dwellers. The lesson of the history of the country is enforced by the citation of the maxim that "it teaches us, all the way through, that Swiss liberty has been won by a close union of many small states."

Biblia, a monthly magazine devoted to biblical archæology, furnishes a current record of what is accomplished in the survey and exploration, particularly of the monuments, of the extremely ancient centers of civilization, gives reviews of literature on the subject, and assists the purposes of the Palestine and Egypt exploration funds and other societies engaged in Oriental investigation. The subscription price is one dollar a year. The publication office for New York is with B. Westermann & Co.

The third of the Manuals of Religious Instruction, Doctrinal Series, published by the New Church Board of Publication, is a series of *Descriptions of the Spiritual World*, for use with children, from the writings of *Emanuel Swedenborg*. The works chiefly represented are the Heaven and Hell, Conjugal Love, and the True Christian Religion.

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Binz, Dr. C. (Bonn). Quinine as a Prophylactic against Malarial Fever. New York: Boehringer & Soehne. Pp. 24.

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Bissell, Mary Taylor, M. D. Household Hygiene. New York: N. D. C. Hodges. Pp. 83. 75 cents.

Borden, John. Two Essays on Economics. Chicago: S. A. Maxwell & Co. Pp. 139.

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Cook, George H. Final Report of the State Geologist of New Jersey. Vol. II, Part II. Zoölogy. New Brunswick, N. J.: Irving S. Upson, Geologist in Charge. Pp. 824.

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POPULAR MISCELLANY.

Pasteur Institute, New York.—From the opening of the New York Pasteur Institute, February 18, 1890, till October 15th, 610 persons that had been bitten by dogs or cats presented themselves to be treated. For 480 of these patients it was demonstrated that the animals which attacked them were not mad. Consequently, they were sent back, after having had their wounds attended during the proper length of time when it was necessary; 400 patients of this series were consulted or treated gratis. In 130 cases the antihydrophobic treatment was applied, hydrophobia having been demonstrated by veterinary examination of the animals which inflicted bites, or by the inoculation in the laboratory, and in many cases by the death of some other persons or animals bitten by the same dogs. All these persons were, on the day of the report, enjoying good health. In eighty cases the patients received the treatment free of charge. The persons treated were—sixty-four from New York; twelve from New Jersey; twelve from Massachusetts; eight from Connecticut; nine from Illinois; three from Missouri; three from North Carolina; three from Pennsylvania; two from New Hampshire; two from Georgia; two from Texas; one from Maryland; one from Maine; one from Kentucky; one from Ohio; one from Arizona; one from Iowa; one from Nebraska; one from Arkansas; one from Louisiana; and one from Ontario, Canada.

The Tuscarora Deep. — Rear-Admiral Belknap, of the United States Navy, read a paper before the Asiatic Society of Japan in Yokohama, in October, describing the deep soundings made by his survey vessel, the Tuscarora, in the Kuro Siwo, last summer, and comparing them with deep soundings in other seas and parts of the ocean. The main object of the Tuscarora expedition was to determine the feasibility of a cable route across the mid-North-Pacific from California to Yokohoma, by way of Honolulu and the Bonin Islands, and on the homeward run to survey a second route from a point on the east coast of Japan, on a great circle running through the Aleutian chain of islands, and ending at Cape Flattery at the entrance of Puget Sound. The mid-Pacific survey had been successfully run, without finding any unusually remarkable depths, and the party anticipated that the return survey would be correspondingly easy. But, putting to sea on the 10th of June, the Tuscarora had hardly got a hundred miles from the coast, when a sounding was made of 3,427 fathoms, the waters having deepened more than 1,800 fathoms in a run of thirty miles. The next cast was still more startling, for, when 4,643 fathoms of wire had run out, it broke without bottom having been reached. Corresponding depths to these were found in all the soundings taken in that neighborhood, the greatest measured being 4,655 fathoms. At 4,340 fathoms a Miller Casella thermometer came up wrecked from the resultant pressure. The time occupied in making a cast of 4,356 fathoms and getting back a specimen of the bottom was two hours twenty-six minutes and fifty-seven seconds. Good specimens were brought up from four of the depths, and in one other the specimen-cup struck rock. At the deepest of the casts the wire parted. In view of the remarkable depths found, the conclusion was irresistible that the great-circle route would have to be abandoned, and a new line of less depth adopted if it could be found. This series of depths, ranging from 3,500 fathoms to 4,600 fathoms and upward south and east of the ridge between Cape Lopatka and the Aleutian Islands, indicates that a trough or basin of extraordinary depth and extent exists along the east coast of Japan and the Kurile Islands and under the Black Stream (Kuro Siwo), exceeding any similar depression yet found in any other region of the great oceans. The depth of the deepest cast—five miles and a quarter, the deepest water yet found—is sufficient to hold two mountains as high as Japan's great Fusijama, and leave them nearly two thirds of a mile under water. This region of the Pacific has been named by the German geographer Petermann the "Tuscarora Deep."

Improvement of Printing-machines.—The first automatic printing-machines, according to Messrs. Southward and Wilson's work on the subject, were invented for calico-printing in 1750. About a hundred years ago, Nicholson took out a patent for a machine applicable to the printing-press. It did not come into use, on account of Nicholson's poverty, and the first practical machine was made by Koenig in 1810, when the Annual Register was printed on his press. This machine was capable of printing a thousand copies in an hour, while no other press then existing could print more than a fourth of that number. Curved stereotype plates were made by Cowper in 1816. Inking by rollers had already been invented. For the last sixty years progress has been very rapid, and every year brings some new machine to save time and trouble, and increase the speed of production. Much attention is now given to type-setting machines, of which six are described by Southward and Wilson as in use. The great difficulty in the use of these machines, which has only now been solved, is in the distribution of the type. It is evaded in the London Times office by taking a cast of the matter, then melting the type and refounding it. One of the latest machines, it is said, however, effects the distribution as rapidly as the setting.

The Aye-aye.—A curious creature is the aye-aye (*Cheiromys madagascariensis*), which was long a puzzle to naturalists on account of its many peculiarities of form and structure. It was named by the French traveler Sonnerat, after an exclamation made by the Malagasy natives on seeing it. It is classified by Prof. Owen as the sole representative of the last of the three families into which the lemuroids are divided. It has eighteen teeth, of which the four front ones—two upper and two lower—are much like those of a rat. Cuvier compared the lower teeth to plowshares. They are powerful cutting instruments, and available for removing wood, making holes in branches, and gnawing through the stems of sugar-canes and other similar plants. The ears are large, round, and open, and have been compared to those of a bat; the eyes are wide and staring; and the upper lip is perfect, or uncleft. The whole body, except the ears, nose, soles, and palms, is covered with thick, dark fur. The most curious peculiarity of the animal lies in the structure of the third and fourth fingers, which are very long, the fourth being the largest and longest, while the third is so extraordinarily thin and wasted in appearance that, as Prof. Owen says, it seems as if it was paralyzed. The use of this finger is described by Prof. Sandwith, who gave his pet aye-aye some sticks to gnaw which were bored by grubs: "Presently he came to one of the worm-eaten branches, which he began to examine most attentively, and, bending forward his ears and applying his nose more closely to the bark, he rapidly tapped the surface with the curious second digit as a woodpecker taps a tree, though with much less noise, from time to time inserting the end of the slender finger into the worm-holes as a surgeon would a probe. At length he came to a part of the branch which evidently gave out an interesting sound, for he began to tear it with his strong teeth. He rapidly stripped off the bark, cut into the wood, and exposed the nest of a grub, which he daintily picked out of its bed with the slender tapping finger and conveyed the luscious morsel to his mouth." The aye-aye is nocturnal, and seldom lets itself be seen in the daytime.

Montezuma's Head-dress.—A study was recently published by Mrs. Zelia Nuttall of a rare object in the Imperial Ambras Collection at Vienna which has been variously described as a Mexican head-dress, a garment intended to be worn about the waist as an apron, and a standard. Whatever it may have been, it was supposed to have belonged to some person attached to the court of Montezuma. The author decides that it was a head-dress. As it is now mounted, on a backing of black velvet, it presents a gorgeous appearance. The long, loose fringe of quetzal-feathers exhibits slight evidence of decay, while the other parts have been carefully restored. The fan-shaped base of the feather-piece is composed of harmoniously disposed concentric bands of delicate feather-work studded with thin beaten gold plates of different shapes. The details of the structure and attachment of these plates confirm what the early Spaniards said about the admirable nicety of Mexican industrial art. The loose fringe was composed of about five hundred of the long tail-feathers, of which each male quetzal bird has but two. Next to it the most striking feature of the specimen is the broad turquoise-blue band of feathers on which a design was executed with small gold pieces, originally fourteen hundred in number, disposed, overlapping one another like fish-scales, so as to form a flexible rectilinear pattern suggesting a series of small towers. The blue of this band was edged with a band of scarlet feathers, so disposed that their inner sides, curling outward, formed a projecting ruffled border. Above this were fringes of the small wing-feathers of the quetzal and of the tail-feathers of the cuckoo, whose white tips formed a sharply defined broad line studded with small gold disks. The whole was skillfully worked upon a suitable backing, and secured by a kind of kite-frame. "Manufactured with the utmost care," says Mrs. Nuttall, "of materials most highly esteemed by the Mexicans, uniting the attribute and emblematic color of Huitzilopochotli, fashioned in a shape exclusively used by the hero-god's living representatives, the high priest and the war chief, this head-dress could have been appropriately owned and disposed of by Montezuma alone at the time of the conquest, from which period it assuredly dates." It was probably one of the gifts sent to the Emperor Charles V by Cortes in 1519.

Influenza and the Weather.—A study of the relations of weather and influenza, so far as they may be illustrated by the registrar-general's reports for London from 1875 to 1890, has been published by Sir Arthur Mitchell and Dr. Buchan. The recurrence of a strongly marked winter maximum and an equally marked summer minimum through the whole forty-five years, with a small secondary maximum running from the middle of March to the middle of April, indicate that the rate of deaths from influenza is inverse to the temperature. The curve showing their distribution is congruent with that for diseases of the breathing organs, with the addition of a slight rise in the spring. But although the epidemics occurred mostly during the cold season, they were not connected with any exceptionally cold weather at that season, but rather with exceptionally warm weather, which manifested itself generally both before and during the epidemic. In no case was any exceptionally cold weather, intercalated in the period of the epidemic, accompanied with an increase of deaths from influenza, or even with an arresting of the downward course of the curve of mortality, if the cold occurred at the time the epidemic was on the wane. Other diseases which appear to have prevailed most extensively during epidemics of influenza are diseases of the breathing organs, phthisis, diseases of the circulatory system, rheumatism, and diseases of the nervous system. The diseases which yielded a mortality under the average during the prevalence of the epidemic were diarrhœa and dysentery, liver disease, measles, scarlet fever, typhoid fever, and erysipelas. The death-rate of persons above twenty years old rose considerably above the average during the four or five weeks immediately preceding the beginning of the registration of deaths due to the epidemic. In studying the dissemination of germs of the disease by winds, it is well not to confine attention to surface winds. It is now found that atmospheric circulation takes place largely through cyclones and anticyclones, by means of which the levels of the currents are changed.

Zigzag Lightning.—It was asserted by Mr Shelford Bidwell, in a lecture at the London Institution, that the zigzag lightning-flash of artists has no existence in nature, but is simply an artistic fiction or symbol; and the speaker produced photographs to prove his point, asserting that not an instance of the zigzag flash could be found among the two hundred specimens in the collection of the Meteorological Society. Mr. Eric S. Bruce has since published a paper for the purpose of showing how the zigzag flash, which is really often seen by observers and is frequently depicted by artists, may have a counterpart in nature consistent with the evidence of the society's photographs. In his view, the appearance is not the flash itself, but is the optically projected image of the flash formed on clouds, not of a smooth surface, but of the rocky cumulus type. The image of the flash takes the angles of the uneven surface and becomes zigzagged. The author has exemplified this process by casting the photograph of a lightning-flash, by means of the optical lantern, on model cumulus clouds, when the "streaming" flash became zigzagged.

Identification by Measure.—M. Jacques Bertillon has described a method now practiced in France of identifying criminals by comparing their measures. Photography is used in it only as an aid to identification established by other means. The basis of the system is to obtain measurements of those bony parts of the body which undergo little or no change after maturity, and can be measured with extreme accuracy to within a very minute figure. Those parts are the head, foot, middle finger, and parts of them, and the extended forearm from the elbow. By the classification of these anthropometrical coefficients, a list including any number of persons of whom photographs are obtained can be divided into many groups containing a small number of individuals each. Stress is laid on the importance of the hand and the ear as marks of recognition. The hand, because it is the organ in most constant use in every calling, and in many trades and professions it becomes modified in accordance with the particular character of the work which it has to do. The ear is the precise opposite to this. It changes very slightly, if at all, except perhaps in the case of prize-fighters, who develop a peculiarity which is easily recognized. It is, therefore, an important organ to measure, inasmuch as the results are not likely to be nullified by a change in the conformation.

Irish Myths.—In his book on the Myths and Folk-lore of Ireland Mr. Jeremiah Curtin regards as insufficient the theories of Mr. Müller and Mr. Spencer, who derive all mythology from a misconception of the meanings of words and a confusion of ideas, and refers its origin to a misconception of the causes of phenomena. "The personages of any given body of myths," he says, "are such manifestations of force in the world around them, or the result of such manifestations, as the ancient myth-makers observed." Mr. James Mooney remarks that the definiteness of detail characteristic of Irish stories contrasts strongly with what is found in other parts of Europe. In Hungary, for instance, the usual introduction is, "There was in the world"; while the Russian story-teller, hardly more satisfactory, informs us that "in a certain state in a certain kingdom there was a man." In the Irish myths, on the contrary, according to Mr. Curtin, we are told who the characters are, what their condition of life is, and how they lived and acted; the heroes and their fields of action are brought before us with as much definiteness as if they were persons of to-day or yesterday. The Gaelic mythology, so far as it is preserved in Ireland, is said to be better preserved than the mythology of any other European country.

From the definite character of the myths, together with the internal evidence afforded by the language itself, it would seem that the Gaelic occupancy of Ireland dates from a very remote antiquity—going back, in fact, to the period of the earliest wave of migration from the primitive home of the Aryans.

Curiosities of African Custom.—Yet new phases of African life and custom are described in the diary of a journey from Bihe to the Bakuba country of the eminent Portuguese trader, Silva Porto. The Kiboko or Kashoko, when their chief dies, either return to their relatives or build themselves a new village. The new chief also builds a new village, and receives a man or a woman from each of his sub-chiefs as a contribution toward peopling it. The *lukano*, or bracelet, bestowed as a symbol of power upon one of the chiefs by his superior for faithful service, is made of brass or copper, interwoven with the sinews of a human being who has been sacrificed on some specially solemn occasion. It is covered with the skin of an antelope, and has charms attached to it. If the holder of this emblem loses the favor of his feudal lord, a messenger, bearing a similar bracelet, but of smaller size, and a two-edged knife, is sent to him, and the disgraced chief—and his brothers and wives usually with him—quietly submits to decapitation. A curious custom, called *shikayandando*, is observed by the Bakuba in concluding a bargain. An offer having been made and accepted, the vender plucks a leaf and presents it to the intending purchaser, who taking hold of it cuts it asunder, when the two pieces are thrown behind. If this mode of confirming a bargain is neglected, the vender can claim double the value of the merchandise in question.

Preservation of Mummies.—A supposition that the mummies of the Egyptian kings in the Archæological Museum at Ghizeh had begun to decay since they were unrolled and deprived of their bituminous coverings was suggested by the appearance of a white efflorescence on certain parts of the mummy of Seti I. In order to ascertain whether this was true, Dr. Fouquet, a person having special qualifications for the work, was invited by M. Grebaut to examine the mummies and the efflorescence, and determine whether signs of decay had been developed since the unrolling; whether the efflorescence was the result of damp, and whether the mummies were threatened with destruction. Dr. Fouquet reported that he had observed the efflorescence on the mummy of Seti I at the time it was unbandaged, June 16, 1886; that a specimen of it examined microscopically was found to be composed of scales and prisms of crystallized salts, with the origin of which dampness had nothing to do, and that in it were neither mycites nor spores; and that efforts to propagate mold on pieces of mummy and mummy-cloth exposed to damp resulted only in sterility. The efflorescence is, in fact, simply an extrusion of the salts employed in the embalming of the mummy, and of the repairs to the same when it was removed, about twenty-three hundred years ago, from its original resting-place to Dahr-el-Bahari. Hence, the mummies are supposed to be safe from atmospheric deterioration.

The Fijians.—In a lecture on the Fiji Islands, delivered at Hokitika, New Zealand, the Rev. S. J. Gibson said that the native population was about a hundred thousand, while the Europeans numbered three hundred thousand. All the natives have embraced Christianity; churches and schools are found in every village, and crime is almost unknown. In the construction of the native houses, chimneys and partitions are not appreciated. The sleeping-place is divided off by mosquito-curtains only. The men are powerful, well developed, with copper-colored skins, and some of the women are of prepossessing appearance. European clothing is used by some of the natives, and gives them occasionally a grotesque appearance. Oiling the body and liming the hair are customary. A dress consisting of a white shirt, a length of white sheeting round the waist, and a sash of native cloth is becoming. Young girls wear a waist-cloth and a sort of pinafore, without either head-covering or boots. The language is musical, but difficult to master; and it is, indeed, almost impossible for a white man to learn it thoroughly. A kind of bread is made by burying fruit with some substance to make it ferment. After a time it is dug up and eaten; but the smell is rather strong at first. Fiji is a commonwealth in the proper sense of the term, all articles being public property. No native lives by trade, and they seem to have no idea of the principles of commerce. They are industrious, and adepts in pottery and wood-work, although their implements are for the most part crude. The native drum, formerly used to sound the war alarm, is now employed to summon people to church, which they all attend.

Ocean Transportation of Plant Species.—Experiments performed by Dr. Guppy at the Keeling Islands, which are six or seven hundred miles from the nearest large land, show that certain kinds of seeds will germinate freely after being thirty, forty, or fifty days in sea-water. During this time they may be conveyed, on a drift current of only one knot an hour, a distance of from one thousand to twelve hundred miles. Some seeds that do not readily float, or float only for short periods, are conveyed hither and thither in a variety of ways—as in the cavities of pumice-stone, and in the crevices of drift-wood. Such seeds as germinate have difficulties in establishing themselves, the most formidable of which are caused by the crabs, which eat the green sprouts as soon as they appear. If the plants escape the crabs in their earliest infancy, they are safe. An evidence of the tenacity of life under unfavorable conditions is afforded by the fact that despite clearing and cultivation, and the introduction of foreign enemies, no species of plant ever known to grow wild on the little islands has become quite extinct.

The Wise Use of Medals.—More discrimination in awarding medals by learned societies is recommended by Prof. W. M. Williams. "Looking critically," he says, "at the awards that have been made during the present generation, it is difficult to find a case in which the honor has not been fairly earned; but still, I think, they have not been as beneficially awarded as they might have been, nor in the manner generally desired by their founders. Most of them were intended as a stimulant, encouragement, and help to scientific workers. Such a medal would be all these to a poor or young or obscure worker, but is none of them to a man whose reputation is established, whose scientific eminence is already attained, and who is already quite sufficiently official." A case in point is that of J. A. R. Newlands, whose duly published discovery in 1864 and 1865 of the periodic law of the chemical elements was not noticed, while the Royal Society's Davy medal for the same discovery was given four or five years afterward to the "official" chemists Mendeleef and Lothar Meyer. But at length, in November last, Newlands received the medal which he had earned previous to either of the other chemists.

Leonardo da Vinci's Theory of Fossils.—M. Charles Revaisson is publishing phototypic *fac-similes* of the manuscripts of Leonardo da Vinci. It seems that nothing which constituted the scientific domain of mankind in the sixteenth century was strange to that illustrious artist. We give here his theory of the formation of fossils: "Of animals which have bones on the outside, such as shell-fish, snails, and oysters, of innumerable species.—When the floods of turbid rivers discharge fine mud on the animals living in the adjoining waters of the sea-shore, the animals remain pressed in the mud, and, being overwhelmed by its weight, necessarily die for want of the creatures on which they are accustomed to feed. The sea receding in time, this mud, the salt water having run off from it, becomes changed into stone, and the shells are filled with sand instead of the animals that have decayed from within them. Thus, in the midst of the transformation of all the surrounding mud into stone, that also which remained within the shells becomes joined by means of a slight opening of the shells with the other mud; so that all the shells are inclosed within the stone—that is, the stone that includes them and that which they contain. These shells are found in many places; and nearly all the petrified mollusks in the rocks of the mountains still have their natural shells—particularly those which had grown old enough to be preserved by their hardness; and the young, being already for the most part reduced to lime, had been penetrated by the viscous and petrifiable humor.

"Of the bones of fish which are found in the petrified fishes.—All animals having bones within their skin which have been covered by the mud of rivers, which have overflowed their ordinary beds, have received to the line the impress of that mud. And with time, the beds of the rivers having fallen, these animals having the impression of the mud which has inclosed them and consumed their flesh and organs, the bones alone remaining—their organization being consumed—they have fallen to the bottom of the concavity of their impression; and in that concavity the mud, when it has been dried by its elevation above the course of the river from its aqueous moisture and then from its viscous moisture, becomes stone, inclosing within itself whatever it finds there and filling everything hollow with itself. And finding the concavity of the impression of such animals, it penetrates subtilely into the minute porosities of the earth by which the air which was in them escapes—that is, by the lateral parts, for it can not escape above, because that porosity is occupied by the humor that descends into the void; and it can not flee below, because the humor already fallen has closed the porosity. There remain the lateral particles opened so that the air condensed and pressed by the humor that descends escapes with the same slowness with which the humor descends. That humor drying becomes stone without weight, and maintains the same form as the animals that have left their impression there, and of which it incloses the bones.

The Taxation of Revolvers.—The following, from the London Lancet, will apply with equal force in this country, where, in not a few cases, the boys even indulge in the senseless and dangerous practice of carrying fire-arms: "The dangerous folly of carrying revolvers was once more illustrated in a case recently tried in the North London Police Court. In this instance a young man, described as being most respectably connected, though without occupation, was accused of threatening to shoot a policeman with whom he had had an altercation. Though he had been drinking, he was not intoxicated. A revolver loaded in two chambers was taken from him. The case is exactly typical of its kind, and requires no further explanation to show the hazard and the uselessness of this custom of habitually carrying fire-arms. Entirely needless for purposes of self-defense, they may become at any angry moment the instruments of hasty and irreparable crime. Another minute and the policeman might have been a corpse and his assailant a foredoomed murderer, all for the sake of a petty difference of opinion. Most persons, we feel sure, will agree with us that the time is overdue for some restrictive measure which will abate this growing nuisance. We would, therefore, advocate once more the imposition of a sufficiently heavy tax upon the possession of these weapons, and of registration in each case of sale. To regulate by such restraints an idle practice and a constant menace to public security implies no injury to, but rather a needful care for, private rights."

The Pamir Table-land.—The name Pamir is not properly the name of any particular spot, but means the country of frozen winds. It is well fitted to the region to which it is applied—a table-land in central Asia, having the height of the Jungfrau, one of the highest of the Alps, and a superficial extent of a hundred thousand square kilometres. In consequence of its height, although it lies in the latitudes of southern Spain, its climate is extremely rigorous. The snow-line varies somewhat, at a height of about fifteen thousand feet, and the zone of cultivation rises to within about fifteen hundred feet of it. Within this zone cereals are raised, and a few good pasture tracts are found here and there. Forest growths are wanting.

About Certain Dye-stuffs.—The principal dye-woods of the Argentine Republic are the *Quebracho colorado*, the *Algorrobo blanco*, the *Corovillo*, and the *Lapacho*. The extract of the quebracho, the chemical constitution of which has not been ascertained, when dried, gives an almost black substance, brittle, and having a characteristic luster. It is used alone to dye wool, and with mordants. The brownish-black sap of the algorrobo gradually solidifies in the air into a resinous and gummy substance that wholly dissolves in water, or into delicate, viscous, and somewhat tough superficial laminæ. Without using any mordant, it produces very fast colors in wool, silk, cotton, and linen goods, varying, according to the application, from the clearest to the blackest brown. The corovillo affords a deep scarlet color, the preparation and application of which are a secret known only to a few families who keep it well. The acid extract from the lapacho—lapachic acid—appearing in greenish-yellow needle-crystals, affords, according to its treatment, rose-crimson, yellow, clear brown, and dark brown. The tree itself has some remarkable characteristics—in the impenetrable density of its inflorescence previous to the appearance of the leaves, the firmness and strength of its wood and its freedom from ash, the resistance of the wood to decay, and the intense induration of its wood when soaked for a considerable time in water.

Speed of Insects.—"Flies," observes a writer in the London Spectator, "frequent the insides of our windows, buzzing sluggishly in and out of the room. But what different creatures are they when they accompany your horse on a hot summer's day! A swarm of these little pests keep pertinaciously on wing about your horse's ears; quicken the pace up to ten or twelve miles an hour, still they are there; let a gust of wind arise and carry them backward and behind, the breeze having dropped, their speed is redoubled, and they return to their post of annoyance to the poor horse. But this example gives only a partial proof of the fly's power of flight. The present writer was traveling one day in autumn by rail at about twenty-five miles an hour, when a company of flies put in an appearance at the carriage-window. They never settled, but easily kept pace with the train; so much so, indeed, that their flight seemed to be almost mechanical, and a thought struck the writer that they had probably been drawn into a kind of vortex, whereby they were drawn onward with little exertion on the part of themselves. But this notion was soon disproved. They sallied forth at right angles from the carriage, flew to a distance of thirty or forty feet, still keeping pace, and then returned with increased speed and buoyancy to the window." The same writer estimates that the dragon-fly, which passes and repasses as in instantaneous jerks, is capable of flying at a speed of from eighty to a hundred miles an hour.

Ambergris. — The word ambergris is French for gray amber, which is a misnomer, for ambergris is a very different substance from amber. The latter is fossilized resin, and is therefore of vegetable origin, while the former is a product of some disease in the sperm whale. Ambergris is sometimes found in the intestines of the whale, but most of the supply is picked up in masses which float on the surface of tropical seas. The best ambergris is soft and waxy, gray in color, and streaked with different shades. It is opaque, inflammable, and remarkably light. It is found in the largest quantities near the Bahamas, but it is a scarce article at best, being quoted in New York at thirty-four dollars an ounce, wholesale. Its use is in perfumery, its great value being due to its powerful odor, which somewhat resembles that of musk, but is much more lasting. It is so peculiar that it has never been successfully imitated. Ambergris is so costly that it is one of the most adulterated articles known in commerce. It is too costly to use alone, but a small quantity of its solution in alcohol is mixed with other perfumes, the blended odor of which it intensifies. A grain or two rubbed down with sugar is often added to a hogshead of wine, to which it gives a pleasing fragrance. A handkerchief perfumed with the famous Parisian compound perfume, *extrait d'ambre*, will retain the odor after several washings.

Strength of the Earth's Crust.—In estimating the strength of the earth's crust, Mr. G. K. Gilbert uses the term crust to indicate the outside part of the earth, without reference to the question whether it differs in constitution from the interior. The conditions of the problem are illustrated by supposing a large tank of paraffin with level surface. If a hole be dug in this and the material piled up at one side, the permanence of the hole or heap will depend on its magnitude. Beyond a certain limit, further excavation and heaping will be compensated by the flow of the material. Substitute for paraffin the material of the earth's crust and the same result will follow, but the limitations of the hole or heap will be different, because the strength of the materials is not the same. Assuming the earth to be homogeneous, the greatest possible stable prominence or depression is a measure of the strength of the material. Having examined a marked example of elevation and depression in the region of the Pleistocene Lake Bonneville and the Wahsatch Mountains, the author deduces the working hypotheses that the measure of the strength of the crust is a prominence or cavity about six hundred cubic miles in volume; and that mountains, mountain ranges, and valleys of magnitude equivalent to mountains, exist generally in virtue of the rigidity of the earth's crust; continents, continental plateaus, and oceanic basins exist generally in virtue of isostatic equilibrium in a crust heterogeneous as to density.

The Dragon-fly and the Cricket.—Mr. E. Giles relates, in the Journal of the Bombay Natural History Society, that in June, 1888, his attention was attracted by a large dragon-fly which was cruising backward and forward in his porch in an earnest manner that seemed to show that he had some special object in view. Suddenly he alighted at a small hole in the gravel and began to dig vigorously, sending the dust in small showers behind him. "I watched him," says Mr. Giles, "with great attention, and after the lapse of about half a minute, when the dragon-fly was head and shoulders down the hole, a large and very fat cricket emerged like a bolted rabbit, and sprang several feet into the air. Then ensued a brisk contest of bounds and darts, the cricket springing from side to side and up and down, and the dragon-fly darting at him the moment he alighted. It was long odds on the dragon-fly, for the cricket was too fat to last, and his springs became slower and slower, till at last his enemy succeeded in pinning him by the neck. The dragon-fly seemed to bite the cricket, who, after a struggle or two, turned over on his back and lay motionless, either dead or temporarily senseless. The dragon-fly then, without any hesitation, seized him by the hind legs, dragged him rapidly to the hole out of which he had dug him, entered himself and pulled the cricket in after him, and then, emerging, scratched some sand over the hole and flew away. Time for the whole transaction, say, three minutes."

Evolution in Floridian Shells.—Except Mr. Edward Potts's article on Fresh-water Sponges collected in Florida, all the papers in Vol. II (December, 1889) of the Transactions of the Wagner Free Institute of Science of Philadelphia are by Prof. Joseph Leidy. They are on Some Fossil Human Bones; Mammalian Remains from a Rock Crevice in Florida; Mammalian Remains from the Salt Mine of Petite Anse, Louisiana; Platygonus, an Extinct Genus allied to the Peccaries; and The Nature of Organic Species. The last paper relates to a series of shells found in Florida which appear to illustrate the transmission or evolution of an extinct form (*Fulgur contrarius*) into that of a living species (*Fulgur perversus*). The changes are illustrated by engraved plates. In this series, as also in a series of *Strombus*, great variability seems to have prevailed among the fossil forms, while the existing species are comparatively stable. Another shell, the *Melongena coronata*, found in the same bed, manifests great uniformity in structure; "while, at the present time, it is probably the most variable shell living on the coast of Florida. . . . We thus find in the same bed one genus that was widely variable in character which now manifests much greater stability in structure; and also two genera that were quite fixed or stable that at the present time are very inconstant." In explanation of this anomaly Prof. Leidy suggests that "no species has been found to be constant or permanent during a long period of geological time; and there appear to have been periods of rest and periods of activity in the transmutation of species. Surviving from the Miocene age, the *Fulgur contrarius* may have been ripe for a change, which was stimulated into action by a cause that would not affect other species, especially such as had not been in existence long. For the same reason the *Melongena coronata* and the *Strombus pugilis* may be active in their inconstancy now, as they have survived from a former period."

Ancient Maps of the Egyptian Desert.—Mr. Cope Whitehouse called attention, in the British Association, to some points in connection with ancient maps of Egypt, Lake Mœris, and the Mountains of the Moon. The revised map of Egypt prepared by the Intelligence Department of the War Office shows a part of the changes effected by the observations of the author. A critical study of the manuscript and printed maps attached to the text of Claudius Ptolemy had enabled him to aver, as a crucial test of their authenticity, that a depression would be found to exist in the desert to the west of the Nile and to the south of the Fayoum. The physical conditions of this region have now been determined with extreme accuracy. The most important maps of the printed editions of Claudius Ptolemy, of the sixteenth and seventeenth centuries, have been reproduced in the *fac-simile* atlas of 1890. Mr. H. M. Stanley's identifications of Ruwenzori with the Mountains of the Moon reversed this method. He found the mountains and then examined the maps and the historical evidence. The existence of ancient originals from which the mediæval copies were made is no longer open to dispute. They have never been submitted to critical analysis. It is reasonable to anticipate other important additions to geographical knowledge as the result of the renewed credit which will henceforth attach to the only atlas which has reached us from ancient days.

NOTES.

In reference to a note in the Monthly for December, 1890, ascribing to Dr. Charles M. Cresson the discovery of typhoid bacillus in juices squeezed from celery, Dr. Cresson desires to observe that the only publication he has made in reference to the bacillus of typhoid in connection with celery, bore upon the practice of certain truck-farmers of ladling upon the plants, for manure, untreated night-soil directly from the carts. Some of the stuff is certain to lodge in the interstices of the plant and not be washed off, and that may contain typhoid bacilli. No claim has been made or facts given that would warrant the assertion that the bacillus was naturally carried in the juice of the plant.

Prof. Pickering describes, in the Sidereal Messenger, fourteen photographs of the planet Mars, which were taken on two successive days, the 9th and 10th of April, seven on each day, in the second of which the southern polar white spot was much larger than in the former series. In the first day's photographs the spot was dimly marked, as if veiled by fog or by particles too small to be represented separately; but on the second day the region was brilliantly white. The date of the event corresponded with the end of the southern winter of Mars, or with the middle of our February; the event itself was a snow-storm.

The fibrous plants of the island and their capabilities will furnish an important department of the exhibition to be held in Jamaica in January, 1891. Among the native plants of this class are those of the aloe, banana, pineapple, plantain, and nettle families. The managers particularly desire to have a full showing of machines for extracting fibers; and liberal prizes have been offered for the best, provided that no less than three manufacturers compete. Small and inexpensive machines are preferred.

Two theories in regard to the treatment of milk have been tested at the Agricultural Experiment Station, at Cornell University, and both proved mistaken. The way generally practiced for getting the most cream from milk is to set the milk in deep cans in ice water. It has been asserted that the addition of an equal quantity of water, either hot or cold, to fresh milk in deep cans would secure rapid and complete creaming. The experiments show that the proposed treatment is not nearly as effective as the accepted one; moreover, when hot water was added, the milk was sour at the end of twenty-four hours, and in some cases the cream was injured for butter-making. Setting in shallow pans in the air was found to give better results than any other practice, except deep setting in ice-water.

In a paper read at the meeting of the American Association, Prof. J. E. Siebel sought to show that certain fixed relations exist between the quality of a water and the geologic horizon from which it is derived in a given locality, and that by measuring and analyzing supplies of different depths, with proper precautions, considerable information can be obtained. In applying his method to the underground water-supply of Chicago, the author found that at least six waters could be differentiated in that neighborhood, each having a well-defined and pronounced character.

Some new Indiana crustacean fossils, described by Charles E. Newlin, are found about half a mile south of Kokomo, in a single ledge of the water limestone of the lower Helderberg formation. They are footprints, and appear to be new to the paleontology of Indiana.

The Appomattox formation of the Mississippi embayment described by W J McGee, which Prof. Stafford identifies with his La Grange formation in Tennessee, corresponds with an area extending from the coast along the Rappahannock River west to the Mississippi and north into Tennessee, which is covered with an interstratified sand and clay, susceptible to erosion and much affected by it. It is said that three fourths of the formation have been removed by erosion. The formation overlaps in irregular lines the Tertiary strata of Virginia. White kaolin, or feldspar clay, is often detected in it, and large quantities of white clay of commercial value have been uncovered in the northern part of Mississippi.

The Redonda phosphate, described by Prof. Hitchcock in the American Geological Society, is found in the volcanic island of Redonda, in the Caribbean Sea—an island with perpendicular walls five hundred feet high, which the visitor must scale with windlass and rope. The phosphates are found, nearly forty per cent pure, nearly devoid of lime, under a vast quantity of guano. They are not crystalline or fossiliferous, and occur in sheets between the layers of lava, or in pockets. The existence of this valuable substance at such a place has never been satisfactorily accounted for.

According to a paper by Prof. S. Coulter, Indiana, which is the fifth lumber-producing State in the Union, has one hundred and six species of trees, belonging to twenty-four orders. The most uniformly distributed tree is the sugar maple, which is found in every county. The author thought that geological formations had comparatively little effect in the distribution of forest trees in the limited area of the State, but that the chief influence came from the elevation of certain general sections and of particular localities, the courses of the streams, and the location of swamps. The forest area of the State has been reduced to 2,000,000 acres, about one tenth of the total area.

Prof. H. W. Henshaw, describing the Indian method of making maple sugar, maintained that the knowledge of the sugar and the process were aboriginal, dating from times unknown, and not in any degree derived from the white man. Indians collect the sap in bark vessels, which in some cases hold a hundred gallons. They take advantage of cold April nights to freeze the sap, and in the morning throw out the ice. They evaporate the sap by throwing hot stones into the reservoirs. They make sugar also from the silver maple and box elder, and, in Canada and Manitoba, from the birch tree. The sugar is eaten mixed with corn. Venison and rabbits are boiled in the hot sap during the process of evaporation. Sometimes pure sugar is the only diet of Indians for a month.

Mr. M. P. Mayo Collier disputes the conclusion accepted by many authors that "flat-foot" is due to a general want of tone in the fibrous structure of the body, and traces it by an elaborate physiological argument to overstrain of the ligaments and overpressure upon the *os calcis*, which may be produced by wearing high heels. For treatment of the malady he recommends good food, fresh air, and as much rest as possible, with a radical change in the construction of the boot. The toe and heel should change places; or a good laced boot should be worn, with the sole an inch thick in front and fining off to a line or two at the heel. By this means the normal inclination of the *os calcis* could be maintained, and the weight of the body properly disposed of.

According to Prof. F. V. Colville's summary, in the American Association, of the organization of the Botanical Division of the Department of Agriculture, the work is divided into two chief parts, the economical and the scientific; the latter includes some special investigations on forage plants in the Western arid lands. The authoritative position of the bureau gives it special facilities for making exchanges with other countries. The results of the work are published as bulletins and contributions from the scientific investigation. An immense amount of valuable material is being collected in the herbarium. A resolution was passed by the Association calling the attention of the department officers to the necessity of better protection for the collections against fire.

Prof. Joseph Moore reports that an entire skeleton of *Casteroides ohioensis*, or beaver of the days of the mastodon, has been found in Randolph County, Ind., a few miles east of Winchester. The bones indicated an entire length of the animal of five feet nine inches, and that its gnawing powers were commensurate with its size.

Prof. O. A. Derby explained to the American Association his method of separation, by means of the *batea*, or Brazilian miner's pan, of rare and heavy accessory elements in rocks. By this means certain minerals, regarded as extremely rare, have been shown to be common and widely spread. By his new method of search he had, on the day of his arrival there, found in rocks of New York State minerals never before found in those rocks in this country.

The Austrian Minister of Public Instruction reported some time ago that the evil of overpressure in the public schools was real and extended, and that its source was not so much in the course of study as in the method pursued. As remedies, he advised a better division of the holidays, and abolition or reduction of written exercises and of memorizing.

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SUPPOSED TENDENCIES TO SOCIALISM.*

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THERE are others besides Herbert Spencer who discern socialism as the end or logical outcome of certain tendencies which now prevail or which are thought to prevail; and, as all prophecies in modern times must be based on what we know of existing tendencies, supplemented by what history tells us of the course of similar tendencies in the past, it is a matter of importance to know how far such tendencies do really exist, and, if they do, to gauge, if possible, their probable momentum, and to judge whether they are likely to be permanent or passing, because confident prophecies have been hazarded on the strength of certain tendencies, while at the very moment of the prophecy a counter-tendency was setting in.†

The alleged tendencies to socialism are chiefly two: the tendency of the state to widen its functions, especially in the economic sphere; and the tendency to increased concentration of wealth. As to the former, there is no doubt that the modern state has a tendency to widen the range of its activity in the economic sphere, as also in the interests of culture, and this tendency is to a certain extent socialistic. The tendency exists; it has increased in England during the present century, especially since the passing of the first Factory Acts in 1844. It has increased especially in the legislative sphere, and as far as the regulation of industry is con-

* From Socialism New and Old, by William Graham. International Scientific Series, No. LXVIII. In press of D. Appleton & Co.

† As in the case of De Tocqueville's celebrated prophecy that nothing could stop the tide setting toward democracy and the equality of conditions, although a counter-tide toward a new inequality had already set in, with, as a consequence of it, the rise of a new aristocracy or plutocracy in all western Europe.

cerned; it will increase further in the interests of the health, the happiness, and the morals of the working class; so in like manner the tendency to assume industrial functions on the part of the central or the local government will increase. Nevertheless, this tendency will not increase fast nor go far, unless a second tendency, which we have now particularly to consider, should develop and show itself socially mischievous.

The second tendency is that toward the increased massing together or concentration of capital which has been going on all through this century, at first as a consequence of the industrial revolution and the needs of the large scale of production, then by the undertaking of ever larger enterprises requiring vast sums of capital, as in the making and working of railways—a tendency which first showed itself in the instance of the great individual capitalist, then in the company or union of capitalists, and lastly, within the past few years, in the syndicate or union of companies. This second tendency does exist; it is likewise an increasing tendency, and, under certain circumstances of abuse into which it would be tempted to fall, it might lead to socialism, not because of its affinities, since it is the very opposite of socialism, but by way of repulsion; it might lead to excessive government regulation, or to the superseding of the syndicates by government management in the interest of the public.

But, before considering the circumstances which might lead to such state socialism, it is necessary to clear away a mistake as to the concentration of capital, to point out a mistaken tendency, which, if it really did exist, would probably lead to socialism by a far shorter road—the mistake that the increasing concentration of capital, which is an undoubted fact, is an increasing concentration or accumulation in ever fewer individual hands; a mistake made conspicuously by Karl Marx, which was indorsed by Cairnes and Fawcett, and which lies at the bottom of all their desires to change the present industrial organization by substituting for it universal collectivism, as Marx would wish, or coöperative production, as the other two prefer.

According to Karl Marx, socialism will come when the process of evolution has resulted in a few colossal capitalists face to face with millions of exploited and expropriated proletarians, including many smaller capitalists who have been undersold and driven into the ranks of the proletariate. "When the constantly diminishing number of the magnates of capital has resulted in a few gigantic ones with a growing mass of misery, oppression, slavery, degradation, and exploitation"; and when, in addition, "the working class, increased in numbers, organized, disciplined, and united by the very mechanism of the process of capitalist production itself, is animated with a spirit of revolt," then, he declares, "the knell of capitalist property will sound, the expropriators will be expropriated." But we can now see that Marx mistook the course of the industrial evolution, and that he prophesied without due allowance for other facts and forces that might check, or cross, or turn the tendency he thought he had divined.

According to Cairnes also, as we have seen, the tendency is to "an increased inequality in distribution. The rich will grow richer, the poor, at least relatively, poorer." And he recommends to the latter co-operative production as their sole hope. Now, Cairnes's mistake was the less excusable, as he wrote at a time (1874) when the tendency to great individual accumulation had received a check, and there were statistics available that might have tested his deduction. And, in fact, all that his argument really proves is that the *class* receiving interest (and occasionally wages of management, in addition to interest) tends to get a larger part of the produce than the *class* that lives by hired wages, or, as he puts it, that the wages fund tends to lag behind the other parts into which capital is divided. This last, if true, would still be a sufficiently serious thing, though Mr. Giffen, the eminent statistician, denies its truth; but, true or not, it is a quite different thing from the increasing concentration of wealth in individual hands, which Cairnes appears, in the above quotations, to think implied in it; that one class, and a large class, tends to get a somewhat larger share than another and a much larger class would not be a desirable thing if it could be prevented; it would scarcely be an argument for a total change in our industrial system, as desired by Cairnes, still less for the further social and political changes desired by advanced socialists.

According to Comte also (writing in 1850), the tendency was to the greater concentration of capital in the hands of individual capitalists; he thought the tendency a good one; far from desiring to thwart it by human volitions, he affirmed that the tendency would necessarily and beneficially lead to a more pronounced capitalism instead of to socialism, and with the capitalists ruling in the political as well as the industrial sphere—so differently did the philosophers forecast the future from the same assumed tendency.

Now, if the tendency were really to the concentration of capital in ever fewer hands, with a mighty mass of ill-paid and discontented workers, and with no great middle class lying between, then indeed the transition to socialism more or less complete would be much easier to accomplish, and in some shape it would probably come; at least it would be easier to expropriate a comparative few; it would be almost impossible to prevent it, the forces of might and justice added to envy being adverse, and with no mediating middle class. Both might and morality would be on the side of the laboring class, and the fall of such a plutocracy might be safely prophesied. But Marx happily was mistaken as to the tendency. The tendency is not to the greater and greater fortunes of individual capitalists. That tendency did, however, exist during and for a certain time after the industrial revolution, especially in England, so long as she had a comparative monopoly of the continental as well as other foreign markets. And the tendency was so marked, it lasted so long, and some men became so rich, that Marx may be excused for generalizing too hastily from it, as undoubtedly he did. That tendency has now almost ceased in England, from increased competition, from the want of the old opportunities, from increased wages, from the spread of companies, and other causes; and though it did exist at the time Comte wrote, according to M. Leroy-Beaulieu it has ceased in France; the law, moreover, having there considerably assisted to check it by the equal partition of inheritances among the children.

The real tendency at present is to the greater massing together of separate portions of capital owned by many capitalists, small, great, and of moderate dimensions; to the concentration of capital certainly, but not to its concentration in single hands; to the union of capitals for a common purpose, while still separately owned. The tendency is to the creation of companies and unions of companies; to the transformation of the larger businesses into companies with larger capital, the original owner retaining a large portion of the shares, and possibly a large influence in the management, if the business is in a sound condition. The tendency is also to give business ability without capital chances of becoming rich through the management of such large concerns, and greatly to increase the number of directors of industry who, without being large capitalists, may in time become considerable capitalists.

The tendency to the concentration of capital, then, does exist as a fact, and socialism might conceivably come as the end of the tendency; only it will not come as the result of its concentration in the hands of a few mammoth millionaires, for the tendency is not toward such in any country save the United States, and even there the tendency is not marked, or it only shows itself in comparatively few instances. It might conceivably come as the result of a universal syndicate and monopolistic *régime*, which, if the monopolists greatly abused their position, might necessitate the state either to regulate stringently or itself to occupy and undertake those industries whose abuses proved incorrigible. But if a partial socialism came in this way, it would give the present system a much longer lease of life, both because the process of monopolistic occupation will probably be slow, and because the capitalists of a given country will not be, as Marx prognosticated, a small number, but hundreds of thousands, probably millions, who would oppose a very powerful resistance to state occupation of a given industry, unless where such occupation was manifestly beneficial for the great majority.

The great multitude interested, the great number of owners of capital, whether in large or small portions, including the more intelligent artisans, would certainly make it difficult or impossible to expropriate them, would indefinitely delay the process, and only those industries could be taken over by the state the functions of which were discharged to the detriment of the community.

If indeed every province of production, distribution, and transport were occupied by syndicates and monopolies; if they abused the natural strength of the monopolist's position by raising prices to the utmost, and especially prices of the prime necessaries, while at the same time trying to reduce wages to the lowest point; if, in short, they were animated solely by egoism, and without conscience, or humanity, or public spirit, the public outside the industrial world, the large and intelligent middle class outside the industrial class, would probably side with the laboring class in pressing on the Government the suppression of the worst of them and the undertaking of their functions.

But, in the first place, the universal occupation of the industrial field by monopolies, and the extinction of competition, is very far off; in the second place, where any large combinations show too much corporate selfishness they can be pulled up by state supervision, and in certain cases great potential combinations can be nipped in the bud, their formation can be prevented by the state refusing permission to the companies to unite as "contrary to public policy" or to public interest; because a company is, in a certain sense, a creation of the state, as is likewise a union, and neither should exist, or receive permission of the state to come into being, if deemed likely to prove inimical to the general weal, so that the state could always check early or altogether the formation of possibly objectionable unions. Where, as in a case like that of railways, they were necessary, it would not be desirable to prevent their formation; they could always be checked if they abused their position, and conditions should always be attached to the concession of powers and privileges to them. It is, therefore, extremely unlikely that the industrial field will ever be occupied by a few colossal and irresponsible syndicates, or that the state will be driven to substitute itself for them, save possibly in a very few cases.

Lastly, the syndicates would have to be devoid not only of conscience, humanity, public spirit, but also, what we can less easily suppose to be absent, common sense and prudence, if they tried to extort the highest prices in cases of necessaries supposed to be controlled by them, or, on the other hand, to reduce wages to the lowest point, on the ground that laborers had no alternative work; such would be dangerous policy for themselves, though no doubt there would be a temptation to it which might prove too great for some employers. Only in such a case of abuse would the state be called upon to interfere, and either strictly regulate or itself undertake the function abused.

But the result of these several considerations is to put off universal socialism indefinitely as a natural evolution, and points merely to the introduction of such partial applications of state socialism as peremptory public exigence may require, in those cases where a social function could not be intrusted to private enterprise, whether monopolistic or competitive.

There is also the tendency on the part of the laborers to co-operative effort, from which some people expect the elevation of the laborers and the composing of the quarrel between capital and labor by merging the two; and this tendency does certainly exist; it is, moreover, in the direction of socialism in the widest sense of the word; only it is a much slower tendency, and a smaller one, more especially in the field of production, as already stated. Of the two tendencies, one to co-operation on the part of labor, and one to the spread and consolidation of companies on the part of capital, the former will not develop fast enough. The company will develop much faster, and socialism might much sooner come as the term of that evolution unchecked than through co-operation. But the one might be restrained by the state, the other might be quickened; the state might become the workingman's bank, to some extent, as it has been the creditor of the farmer in Ireland; it might lend at market rate, three or three and a half per cent, to such associations of workers as had saved a moiety of capital, if they could show the likelihood of success in their projected enterprise. But as this point has already been considered, it is not necessary to enlarge on it here any further than to say that the working classes, now that they have got so much political power, may not improbably press for some state assistance to increase the numbers of owners of capital, especially as the results of unaided efforts must be extremely small and slow.

What political action to improve their economical position they may take can not be precisely stated. It is by no means likely that they will ever combine to demand a maximum working day in England. They will not ask the help of the state for the purpose; nor will they, with the socialists, ask it to fix a minimum of wages, which they can if they choose themselves fix through trades-unions. They may ask for the nationalization of the land; though it is not clear, if landlords were compensated, what they would gain by it beyond the creation of small farmers, the granting of allotments to agricultural or other laborers, as an occupation for slack times, all of which may be secured otherwise: so that it is not easy to forecast the resultant line of action of the working classes, more especially as the interests of the skilled and unskilled laborers are not always identical, however the desires for higher wages and fewer hours may be common to both.

Thus far as to the existing tendencies. As to the final goal, it is very difficult to say what it will be, or what the end in which society will rest (if, indeed, it ever attains to rest other than provisional equilibrium). And it is difficult because of the new and unforeseen factors that arise in the course of an ever-expanding evolution which might upset our calculations. New factors, industrial, social, moral, religious; new physical discoveries, like steam or electricity, that might revolutionize industry; new moral or religious forces that might revolutionize manners and the scheme of life, and with it indirectly the distribution of wealth; and great physical discoveries and inventions affecting industry—we may indeed certainly look for as in the normal course of evolution.

Society *may*, indeed, come to the collective ownership of land and capital, but it will not be for a long time; it *may* come to equality of material goods, but it will be at a time still more remote. On the other hand, the system of private property and freedom of contract may last indefinitely or forever; but, if it does, we may safely prophesy that it will be brought more in accordance with reason, justice, and the general good, and, though there be never equality of property, there will be a nearer approach to equality of opportunities, and a somewhat nearer approximation of the existing great extremes of fortune.

Eminent writers during the past hundred years have prophesied far more confidently as to the future: Karl Marx, as we have seen, that the concentration of capital in the hands of a few would lead, naturally, necessarily, and at no distant date, to their expropriation, and to a collectivist *régime;* and De Tocqueville, that society was being borne invincibly to a state of general equality of conditions, where the state would continally become more powerful. On the other hand, the sociologists, who, if their science were all that its name implies, should be able to forecast the future, "to look into the seeds of time and say which grains would grow and which would not," predict very differently: Comte, that the concentration of capital in ever fewer hands would and should lead definitely to the political rule of the capitalists, tempered by the counsel of positive philosophers, and that within a short space of time; while Herbert Spencer, as we have already seen, filled with the doctrine of evolution, and impressed with the lesson it teaches as to the length of time required for changes for the better, discerns at "the limits of evolution," countless generations hence, as goal, a system of property and contract, purified and supplemented by voluntary benevolence, with the authority of the state reduced to a minimum.

In like manner Mill prophesied; but his conclusion was different. He prophesied that co-operative production, "sooner than people in general imagined," would transform society by superseding the capitalist employer; and with respect to the two exactly opposite prophecies of Mill and Comte, all that need be said is that neither of them has been as yet fulfilled. Co-operative production has not advanced, nor, on the other hand, has the capitalist attained supreme political power, though of the two perhaps the prophecy of Comte has come nearer to fulfillment.

When De Tocqueville wrote his remarkable book on "Democracy in America," the new tendency to inequality had not shown itself in America, there *was* great equality of conditions, and there was likewise considerable equality of conditions in France as a consequence of the Revolution. De Tocqueville generalized from what he then saw, and prophesied a further and a general equality, though somewhat prematurely, because a tendency to a prodigious inequality was setting in at the time he was writing, a tendency first manifested in England, that increased, spread, embraced the civilized world, that was followed by a new social conquest, and the rise of a new and potent moneyed aristocracy. It grew greater; and, generalizing from this tendency, Karl Marx prophesied it would grow still greater until all capital was concentrated in a few hands; the capitalists would then be expropriated, and socialism and equality would come. But Marx, as already stated, based his prophecy on a misread tendency, a short tendency which had spent its full force before he died, just as De Tocqueville based his prediction on a supposed tendency gathered from the facts of a generation earlier. Both were wrong: a great current toward inequality came, especially in America, after De Tocqueville wrote, in 1835, just as there came a check to the concentration of capital in fewer hands, and a tendency to its dispersal, before Marx died.

Others also have prophesied in our century, though without pretending to base their predictions on the scientific study of political or social phenomena: St. Simon, that the golden age was in the future, and that society would reach it through his doctrine; Carlyle, that the abyss lay before society, unless the Great Man appeared to save it. To the like effect the poet-laureate also speaks: "Before earth reach her earthly best a God must mingle with the game."

What is the lesson to be gathered from the prophets and writers on the science of society? Not that we should expect an early and radical transformation of society; neither the supremacy of a few capitalists, nor yet their early expropriation; hardly even that we should expect the coming of the semi-divine man of Carlyle and Tennyson to set things right. The chief lesson is the rashness and exceeding doubtfulness of specific prophecies which are grounded as often on hopes or fears, likes or dislikes, as on superior insight. The prophets are, however, in general optimistic; they believe in progress or evolution; and they believe that civilized society is progressing to something better than the present state, though they differ considerably as to what constitutes that better. I share this faith, on the whole, myself. I believe that society is in movement as part of an inevitable process to something better in the end, though some of the stages to it may appear to be really worse for particular generations. I believe we are moving toward a better, to "a far-off divine event" which can not be fully perceived at present; and I believe that the road to it lies through something better than the present which can be perceived. To get to this better will require the co-operative efforts and volitions of men, especially of the working classes, and of their leaders. Social thinkers will be required to furnish light and guidance, and also, it may be, great statesmen filled with the spirit of understanding and justice, and with regard for the general good. There will be neither miracle wrought, nor sudden social transformation, which would be a miracle in order to last; but with good sense, self-reliance, and persistence on the part of the many, assisted by the light and help of the few, and with better dispositions on the part of employers of labor, a considerable advance for the whole people, and especially for the cause of labor, might be made during the present generation; while, with these same conditions as permanent facts, the movement for social reform, if not the socialistic movement, will advance as fast as is desirable, and will realize in future as much good as the nature and complexity of things social and things human will allow.

The scheme for an exploration of the antarctic regions is gradually assuming shape. A report was made at the meeting of the Royal Geographical Society of Australasia in August, that Baron Nordenskiöld would consent to take command of an expedition on condition that the Australian colonies contribute five thousand pounds toward the expenses, to be met by a like contribution by Nordenskiöld's friend Baron Oscar Dickson. The Geographical Society, which had already pledged itself to support a South Polar Expedition, accepted the proposition of the Swedes at once, on the faith that the necessary subscriptions would be secured, and itself contributed two hundred pounds toward the amount.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

IV. IRON-WORKING WITH MACHINE TOOLS.

By WILLIAM F. DURFEE, Engineer.

WHILE the builders and operators of blast-furnaces were achieving such splendid results as have been described, the owners, managers, and engineers of rolling-mills were not idle. At the very beginning of rolling-mill construction in America the disposition to make improvements in known methods and to invent entirely new mechanisms and processes was promptly manifested. Even in the first mill of which we have any authentic account the rolls and heating furnaces were decided improvements on previous practice; and from that day to the present time the best American rolling-mill practice has been characterized by originality of idea and perfection of construction. Fig. 41 is a longitudinal sec-

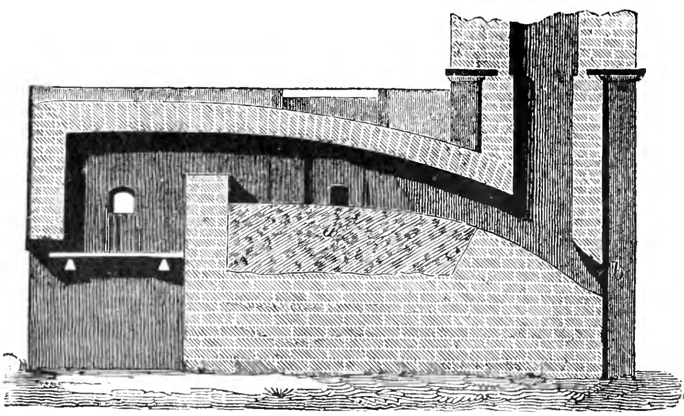

Fig. 41.—Longitudinal Section of a Heating Furnace.

tion of a heating furnace in which coal was used as a fuel. The "fire-box" with its grate is seen at the left; to the right of this is the "bridge-wall" separating the "heating chamber" from the "fire-box." The bottom, *a*, of the "heating chamber" is made of silicious sand. On the extreme right of the furnace is seen the "cinder-tap," *b*, for the discharge of any liquid "cinder" made during the operation of heating the iron; near this "cinder-tap" is the lower part of the "chimney-flue." The iron to be heated was placed upon the sand bottom *a*, and the flame from the fuel in the fire-box passed over it, not only heating the metal directly but the roof and side walls and bottom of the heating chamber also, which, as was said when this form of furnace was first introduced, "reverberated" more heat upon the metal; hence the name "reverberatory furnace" often applied to such structures. The walls, roof, fire-bridge, and chimney-flue are built of very refrac-

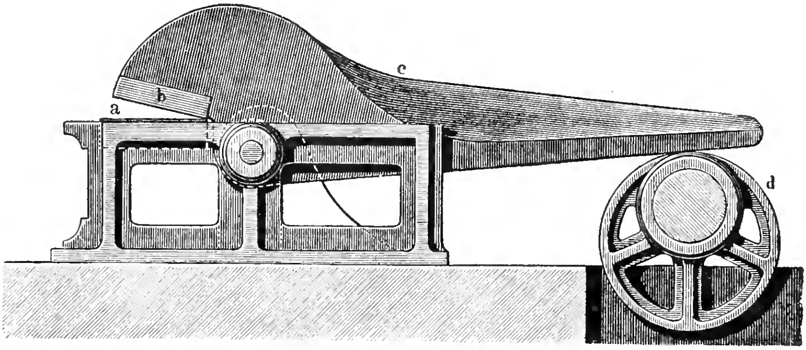

FIG. 42.—LEVER SHEARS FOR CUTTING BAR IRON.

tory brick, called "fire-brick." Furnaces of similar construction (sometimes called "air-furnaces") are used for melting pig iron for making heavy castings; but in these furnaces, instead of a

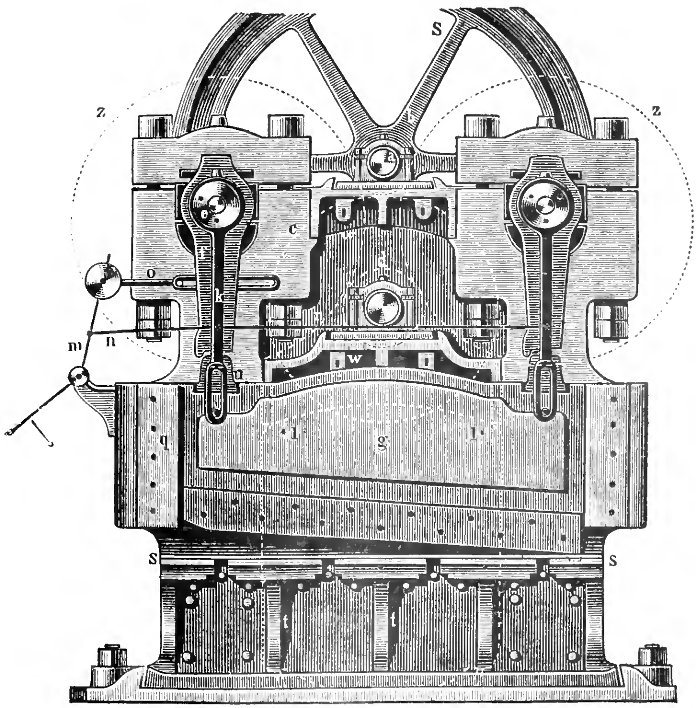

FIG. 43.—FRONT ELEVATION OF BOILER-PLATE SHEARS.

sand bottom of the form shown at *a*, the furnace at this part has its bottom depressed so as to form a basin to hold the fluid metal. Thirty to fifty tons of metal are sometimes melted in such furnaces.

Among the machine tools used in rolling-mills those called by the general name of "shears" occupy an important place; these tools vary greatly in form and constructive detail, and are designed with especial reference to the work for which each is intended. Fig. 42 is an illustration of a common form of lever shear for cutting bar iron. The cutting knives are located at *a b*, and when the eccentric *d* is revolved by the rotation of the shaft on

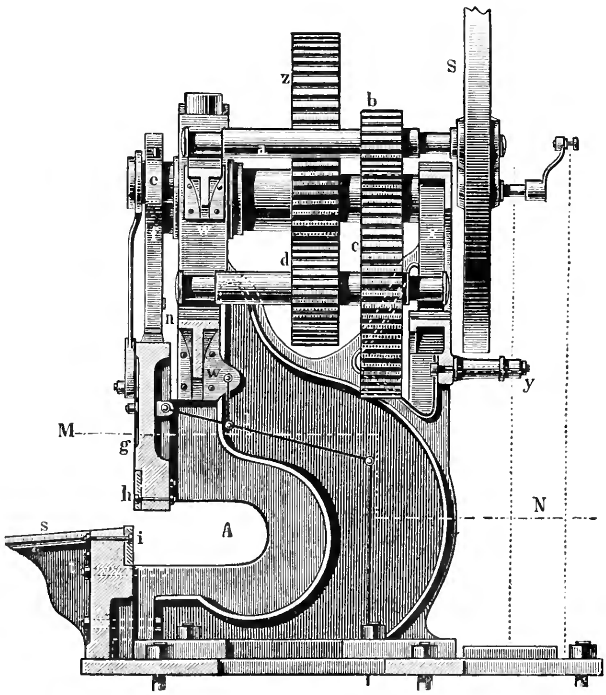

Fig. 44.—End View and Transverse Section of Boiler-plate Shears.

which it is placed, it lifts the long arm of the lever *c* and causes the upper knife *b* to cut or "shear" past the lower knife *a*, thus dividing any bar of iron that may have been between the two knives.

Fig. 43 is a front elevation of a "shear" for cutting boiler plate, and Fig. 44 is an end view and transverse section of the same machine.

In Fig. 43 at *g* is seen a large mass of cast iron, to the lower edge of which is attached a long, inclined cutting knife, which is designed to operate in conjunction with a straight knife attached to the frame of the machine (the relative positions of the two knives are shown in Fig. 44 at *h* and *i*) to shear any sheet metal placed between them. The "gate" *g*, to which the upper knife is attached, has a vertical reciprocating motion communicated to it by means of the eccentrics *e* and the rods *f*, and, as the upper knife *h* has an inclined edge, the shearing will commence on the right and gradually extend to the left as the "gate" *g* descends. Shears of this description have been made to cut ten feet in length at one movement of the "gate" *g*. Such tools are very heavily geared, and are usually driven by a special steam-engine.

The first iron-works in the United States in which iron was puddled and rolled into bars was built by Colonel Isaac Meason, in 1816 and 1817, at Plumsock, on Redstone Creek, between Connellsville and Brownsville, in Fayette County, Pennsylvania. Swank tells us that "Thomas C. Lewis was the chief engineer in the erection of the mill, and George Lewis, his brother, was the turner and roller. They were Welshmen."

We have no exact description of the machinery of this mill, but we are told that, in addition to the rolls, "the mill contained two puddling-furnaces, one refinery, one heating furnace, and one tilt-hammer"; and that "the iron was refined by blast and then puddled." This mill produced "bars of all sizes, and hoops for cutting into nails." The mill was started on September 15, 1817,

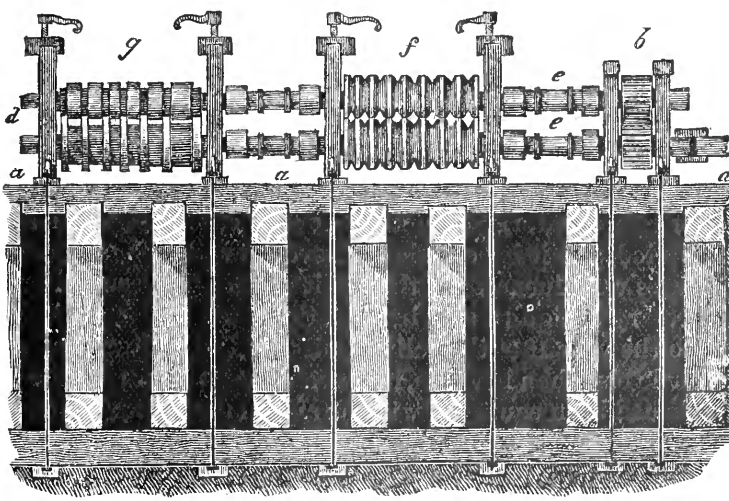

FIG. 45.—TRAIN OF ROLLS FOR SQUARE AND FLAT BAR IRON (1817).

and continued in operation until 1824, when it was destroyed by a flood, and never rebuilt. Although we have no details of the roll train used in this mill, it is fair to assume that, as its designers were Welshmen, they followed as closely as possible the practice with which they were familiar. Fig. 45 is an elevation of a train of rolls such as was in common use in England and Wales at the beginning of this century for rolling square and flat bar iron. In this figure, *a* is the foundation sill of the mill. This sill rested upon some heavy frames of timber, which in turn were supported by a pair of bottom sills; the "stands" or "housings" in which the rolls turned were placed directly on the timber sills, *a*, and secured by long bolts that passed through the lower sills. At this period, and for some years thereafter, in fact, timber foundations for rolling-mills were considered absolutely necessary, in order to impart a certain degree of elasticity to the machinery; and when we consider the rude way in which all machinery was constructed at that time it is not improbable that some elasticity was essential to its operation.

In Fig. 45, at *b*, are seen the "pinions," which were a strong pair of toothed wheels of the same diameter which served to insure an equality of rotation in the top and bottom rolls of the mill. These pinions were connected with the rolls by the spindles *e e*. The rolls at *f* could be used to make square bars, or to "rough down" the iron preparatory to passing it through the rolls *g*, which were intended for flat bars of various widths and thicknesses. This construction of rolling-mill is what is known as a "two-high train," and is so called from the fact that each pair of "stands" or "housings" contains but two rolls placed one above the other. It is obvious that, as the rolls revolve constantly in one direction, the iron, after passing through one of the grooves, would have to be returned over the "top roll" before it could be passed through the next groove for further reduction in section and extension in length. It is also evident that such a method of working wasted half the time and a large amount of the heat of the metal; but, notwithstanding these and other quite as serious objections to this form of mill, it continued in use until a very recent period, and it is possible that even now there may be found, in localities uninfluenced by the spirit of progress, some examples of this rotary antiquity still in operation.

Up to the year 1844 the rolling-mills of the United States produced little else than bar iron, hoops, and nail plates; all the early railroads had been equipped with strap rail (flat bar iron provided with "countersunk" holes at proper intervals, through which passed the spikes by which the "rail" was secured to longitudinal stringers of wood), which could easily be rolled in this country; or with imported T or H rails. The T rail is of American origin, it having been invented by Robert L. Stevens, President and Engineer of the Camden and Amboy Railroad. Mr. Stevens had the first of these rails rolled at Dowlais Iron Works, in Wales, and they were laid in the track of the Camden and Amboy Railroad in 1831–'32.

The first heavy railroad iron of America manufactured was made at the Mount Savage Rolling Mill, in Alleghany County, Md. This mill was designed expressly for this class of work. The first rail rolled was what is known as the U rail, and for this the Franklin Institute awarded its silver medal in October, 1844. Such was the demand for railroad iron that other mills for its

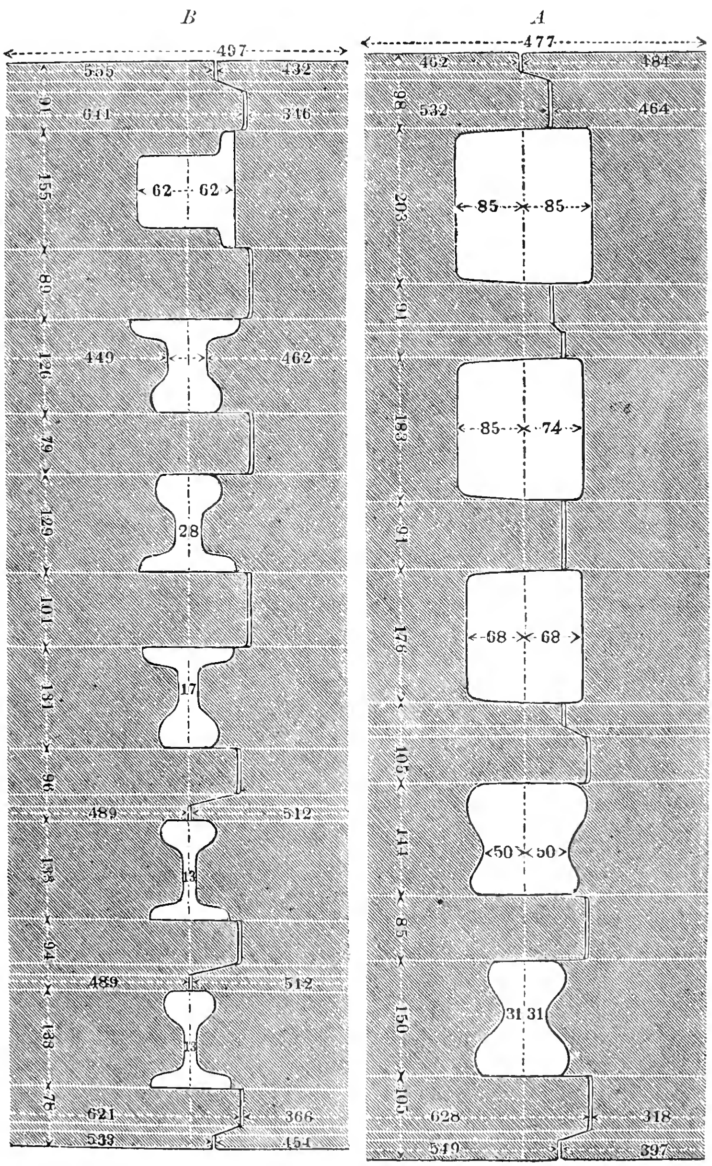

Fig. 46.—"Grooves" in Rolls of "Two-high Train" for Rolling Rails (1850).

production were rapidly constructed. The Montour Rolling Mill at Danville, Pa., was built in 1845, and in October of that year turned out the first T rails made in America. On the 6th of

May, 1846, the Boston Rolling Mill made its first T rail, and on the 19th of June, 1844, the rolling-mill of Cooper & Hewitt, at Trenton, N. J., commenced rolling rails. About the 1st of September, 1846, the New England Iron Company, at Providence, R. I., made their first rail. Railroad iron was rolled at Phœnixville, Pa., in November, 1846, and about the same time at the Great Western Iron Works at Brady's Bend, and at the Lackawanna Iron Works at Scranton, Pa. Rails were also rolled, early in 1847, at the Bay State Iron Works in Massachusetts; in January, 1848, at the Rough-and-Ready Rolling Mill at Danville, Pa., and in the same year at Safe Harbor, Pa., and at Avalon, Md. Some few other mills rolled rails prior to 1850, but at the beginning of that year, owing to the severity of foreign competition, only two out of the fifteen rail mills in this country were in operation.

The rail trains in all the above-named mills were "two high"* (that is, one roll above another in pairs), and a general idea of the forms of the several "grooves" or "passes" in the rolls used in a two-high rail train may be derived from an inspection of Fig. 46. A two-high rail train comprised two pairs of rolls, one pair being called the "roughing rolls" and the other "the finishing rolls." Their general relations to each other were quite similar to the rolls of the "bar-mill," shown in Fig. 45.

In Fig. 46, *A* represents the five "passes" in the "roughing rolls," and *B* the six in the "finishing rolls." The progress of the metal was from left to right, through each of the "passes" in each roll successively. We have no space to describe in detail the peculiar features of the three-high train; but its more prominent peculiarity consisted in the fact that there were three rolls in each pair of housings, and that the "rail," or other form of bar being rolled, was passed between the middle and "bottom roll" and returned between the middle and "top roll," and received compression and extension at each "pass."

Fig. 47 gives a very life-like view of the interior of a rolling-mill as constructed about the year 1855. It will be noted that the "trains of rolls" are all "two-high," and that the building is evidently constructed of wood; and the large number of men employed is also a conspicuous feature. To those at all familiar

* For the manufacture of heavy "bar iron" and "structural shapes" ("beams," "channel bars," "angle" and "tee iron") the "three-high rolls" are a development of American practice due to the ingenuity and practical sagacity of the brothers John and George Fritz, who erected the first mill of this kind for rolling rails at the Cambria Iron Works at Johnstown, Pa., in 1858. Such were the manifest advantages of their system that it was at once adopted by many of the larger rolling-mills, although as late as 1865 there were a few mills rolling rails on the old "two-high trains." I well remember advising in 1862 the removal of an ancient "eighteen-inch two-high rail train," and the putting in its place of a "twenty-one-inch three-high train," and the opposition and ridicule over which that advice finally triumphed.

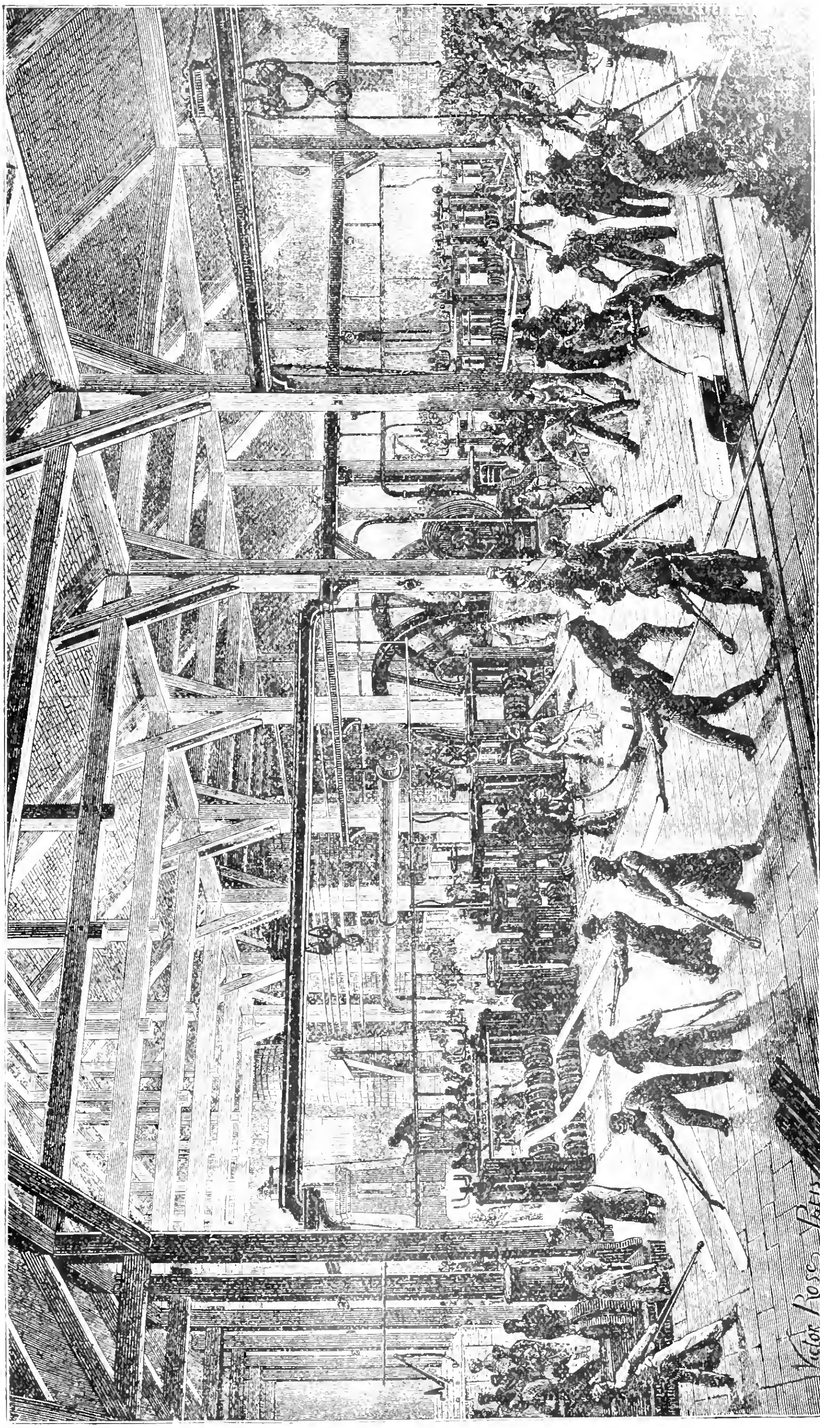

FIG. 47.—INTERIOR OF A ROLLING-MILL (1855).

with such establishments, it will require but a slight effort of the imagination to impart to the picture all the attributes of real life; and to fill the sooty air with the hissing of steam, the jigging jingle of coupling-boxes and spindles, and the groaning of rolls, among which sounds are injected the resounding blows of a steam hammer, answered by the clattering scream of a "cutting-off saw," mingled with the hum of revolving wheels, and scores of minor sounds and reverberations; over all, the lurid glare of furnaces and hot iron, amid which the busy workmen move in orderly activity at the work in hand; the whole making a scene in which the strength of man and iron, the energy of fuel and fire, and the power of steam and machinery are combined as in no other industry on the surface of the round world.*

The rolls for making heavy bar iron of a rectangular section, hitherto described, have been provided with a number of "grooves" or "passes" of varying dimensions suited to the sizes of the bars required; but the manifest objection to this very common arrangement is that, in order to be able to produce a large variety of bars, a great number of rolls must be kept in stock. But the mill represented in Fig. 48 is so contrived that it will roll an almost unlimited number of sizes of rectangular bars by the use of a combination of four plain cylindrical rolls, two of which revolve on horizontal axes, and the other two on vertical ones. In the figure, for the purpose of clearness, the driving mechanism of the vertical rolls is omitted. Each of the pairs of rolls is driven at an appropriate velocity, and is adjustable, so as to adapt their relative positions to the particular cross-section of bar about to be made. The horizontal rolls can be adjusted vertically and the vertical rolls horizontally, and therefore any proportion of width and thickness can be turned out, up to the limitations imposed by the width of the cylindrical portion of the horizontal rolls and the length of the body of the vertical rolls. This highly ingenious mechanical combination was invented by Herr Daelen, a German engineer, and it was first erected

* The Plutonic appearance of most iron-works was fully appreciated by the poet Burns. Sir John Sinclair, in his Statistical Account of Scotland (1797), states that the "Ayrshire poet" was refused admission to the Carron Iron Works, and, "upon returning to the inn at Carron, he wrote the following lines upon a pane of glass in a window of the parlor:

"'We cam na here to view your warks
In hopes to be mair wise;
But only, lest we gang to hell,
It may be nae surprise.
But when we tirl'd at your door,
Your porter dought na bear us;
So may, should we to hell's getts come,
Your billy, Satan, sair us.'"

at the works of Piepenstock & Co., belonging to the Hörder Society, in 1848. It found its way to America about twelve years later; but it has not received the attention from American engineers that the value of its constructive ideas justifies.

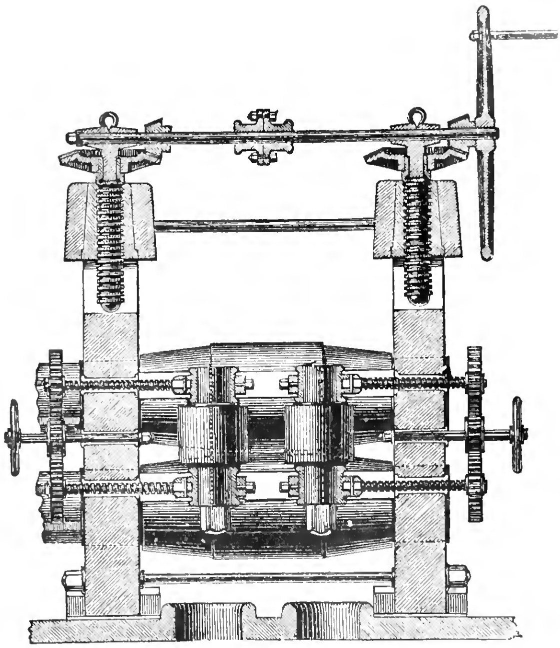

Fig. 48.—Universal Mill.

The first iron beams for use in buildings rolled in America were made in the mill of Messrs. Cooper & Hewitt, at Trenton, N. J., in the spring of 1854. They were seven inches deep, weighing about eighty-one pounds per yard. They were used in the construction of the Cooper Institute and the building of Harper & Brothers, and also by the Camden and Amboy Railroad for rails. A special "train of rolls," the invention of William Burrows, was constructed for doing this work. An elevation of the "finishing rolls" of this "train" is given in Fig. 49. It will be seen that there are three short rolls, A A A, whose axes are vertical and supported by a cast-iron frame or housing, D D. Besides these vertical rolls there are two horizontal rolls, E E. The power was transmitted to the mill from the main driving-shaft B, through the bevel gearing B^1, B^2, the three spur-gears B^5, and the spindles B^8. This was the only mill of its kind ever erected, and after a few years it gave place to a "three-high train," which is the kind of mill exclusively used in America at the present time for the manufacture of the various forms of "beams," etc., known as "structural shapes."

The space available will not permit of a detailed description of the various improvements in machinery and methods that have been brought forward within the last thirty years, and we can only briefly mention the more prominent.

In 1859 John and George Fritz (*par nobile fratrum*)* patented

* A noble pair of brothers.

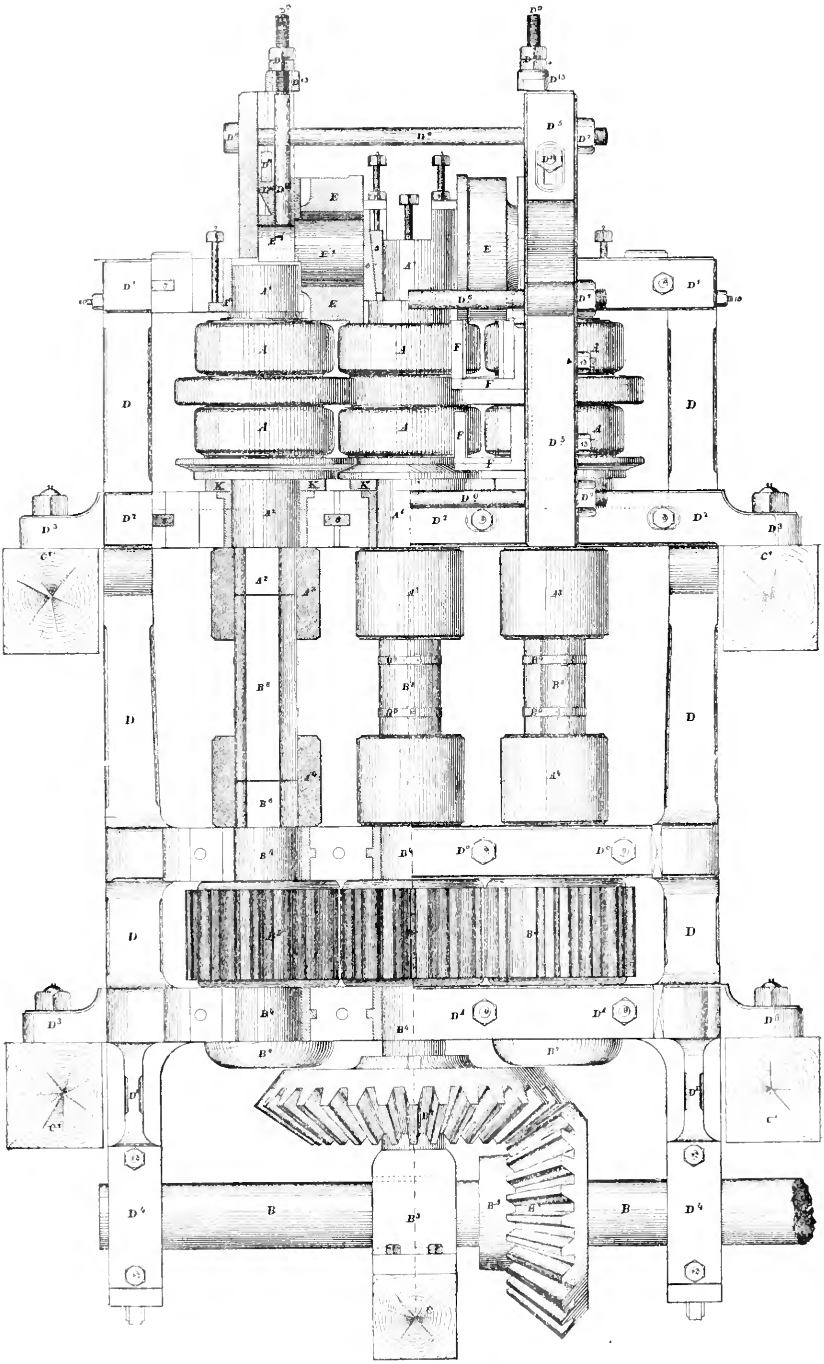

FIG. 49.—ELEVATION OF "FINISHING ROLLS" FOR BEAMS—COOPER & HEWITT.

important improvements in "three-high" mills, embracing what is known as the "feed-roll" and "hanging guides." In 1864 Bernard Lauth patented the well-known form of "three-high mill" (often called "Lauth's mill") for rolling boiler plate and sheet iron. In 1872 James Moore and John Fritz patented a "three-high train," having a fixed middle roll and an adjustable top and bottom roll; and in the latter part of the same year George Fritz patented "feeding tables having driven rolls" for "three-high trains."

In December, 1873, James Moore, William George, and Alexander L. Holley patented a "three-high blooming train," having an adjustable middle roll. The first mill of this kind was made by James Moore, of Philadelphia, and was put at work in the Bessemer Steel Works at Troy, N. Y., by the late A. L. Holley, who was then manager of these works.

Among the more recent improvements in the manufacture of iron and steel the use of gaseous fuel stands conspicuous. The idea of first converting the fuel into a combustible gas, and conveying this to the point where heat was required, and there igniting it, is a very old one,* and, in one form or another, it has been employed for over a thousand years; but it is only within the present century that the manifold advantages of gas as a metallurgical fuel have become fully recognized by the iron and steel workers of the world. The early gas furnaces used in Silesia, Sweden, and other European countries were but enlarged modifications of Geber's Tower of Athanor, and, although they were a great improvement on the furnaces in which solid fuel was burned on a grate, yet they were not able to produce a temperature sufficiently high and controllable to satisfy the demands of the rapidly developing iron and steel industries.

The gas furnace most commonly used in the American iron and steel works was invented about thirty years ago by the brothers Frederick and Charles William Siemens, German engineers resident in London. The first "Siemens furnace" built in this country under the sanction of these inventors was erected at the works of John A. Griswold & Co., at Troy, N. Y., in 1867, and was used as a "heating furnace." † This was followed in the

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* The first gas furnace of which we have any exact account was invented by Abu Musa Dschabir, more commonly known as Geber, an Arabian alchemist, who lived in the eighth century. The furnace invented by Geber he called the Tower of Athanor, or the *undying* one, because from its construction a steady and uniform heat could be maintained for an indefinite period.

† Previous to this, however, in 1862, there had been erected, at the copper-works of Park, McCurdy & Co., in Pittsburgh, a "Siemens furnace" for refining copper; and in 1864 Park Brothers & Co. (also of Pittsburgh) built one of these furnaces for heating steel; and in the same year, in a neighboring establishment (James B. Lyon & Co.) one was con-

same year by a heating furnace at the works of the Nashua Iron and Steel Company, Nashua, N. H., and early in 1868 the first "Siemens furnace" for melting steel in crucibles (often called a "pot furnace") was started in the works of Anderson & Woods at Pittsburgh.*

The first works in which the "Siemens gas furnaces" were used, to the exclusion of all other methods of burning fuel, were those of the American Silver Steel Company, at Bridgeport, Conn., which were erected from the plans and under the supervision of the author of these papers in 1868–'69. In these works were two puddling furnaces,† three heating furnaces, one twenty-four-pot melting furnace, a twenty-four-pot muffle, and ten "gas-producers," all on the Siemens principle. Gas from the "producers" was used under the boilers with entire success. At the time of the erection of these works they were the largest and most perfect plant of gas furnaces in America.

"Natural gas" has been known to the nations of the Old World for thousands of years. The Persian fire-worshipers used it for their sacred fire, and it has been used as a fuel in China since a time beyond the range of authentic history.

The earliest use of natural gas in this country was as an illuminant in the village of Fredonia, N. Y., in 1827, and it is still used there. The first person to use natural gas for manufacturing purposes is believed to have been Mr. William Tompkins, who, in 1842, employed it in the Kanawha Valley for heating the kettles of a "salt-block" one hundred feet in length. In 1845 Messrs. Dickerson and Shrewsbury bored a well on the Kanawha River, in West Virginia, to a depth of one thousand feet, from which a sufficient quantity of gas issued, according to a computation by Prof. B. Silliman, Jr., "to light the city of New York for twelve years." The first use of natural gas for the manufacture of iron was in the Siberian Rolling-Mill of Rogers & Burchfield, at Leechburg, Armstrong County, Pennsylvania, in 1874; twenty-nine years after it had been successfully used under a "salt-block" in West Virginia, and forty-seven years after its first use for light-

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structed for melting glass. None of these furnaces were built from the inventors' plans or under their license, and all were abandoned after a short life.

* All these furnaces, and many subsequently constructed, were built from the plans of J. Thorpe Potts, an English engineer, who was one of the firm of Richmond & Potts, representatives of the inventors in this country.

† These furnaces were the first successful gas puddling furnaces constructed, and although their performance was in every way satisfactory, and the works were visited by every prominent iron manufacturer in America, it was many years before puddling with gas became popular with the iron-masters of the country; in fact, it was not until the introduction of "natural gas" that the great value of gaseous fuel began to be properly appreciated, and even now there are new works for the manufacture of iron being erected, in which the puddling furnaces are not in any way better than those in common use in 1840.

ing at Fredonia, N. Y. But now gas wells increase and multiply in the land, and lines of pipe radiate from them in all directions, conveying silently as the lapse of time, to city and mill, forge and furnace, their heat-giving product that has lain dormant in the earth for untold centuries, but which now, at the summons of modern Science, comes forth from its abiding-place to do no small share of the work of the world. Many of these lines of pipe are of great length,* and suggest the possibility of converting coal into gas at the mines and conveying it to consumers in distant cities by pipes; and this proposal in our day is not nearly as uncertain of realization as was the original idea of lighting cities and buildings by gas at the time of its invention, one hundred years ago.

[*To be continued.*]

HYPOCRISY AS A SOCIAL ELEVATOR.

By JOHN McELROY.

WHEN atrabilarious Hamlet, in his choleric interview with his mother in the cabinet, impudently advised her to

"Assume a virtue if you have it not,"

he unwittingly laid down a general-conduct rule of high value to individuals and the community.

Simulation of virtue, though far inferior to the real article, is still the next best thing to it, just as whitewash, though much inferior to marble, is yet greatly superior to dirty nakedness.

It is very desirable that all men and all women should stand together on the very highest plane of goodness; but the largest proportion of them do not—probably never will. It is unreasonable to expect that the mass of humanity will be steadily aligned on the most advanced standards of morality, especially when those standards are pushed forward as rapidly as they have been in the more recent centuries. Ethics is a constantly developing science. What was a high grade of morality in the eighteenth century would be a very ordinary one to-day; just as the man who, in our colonial times, would have been regarded as neat and cleanly in his person, would seem a good deal of a sloven to-day. Then, as now, men and women assumed to be much cleaner, morally and physically, than they really were, and by sheer force of persistence and habit became really cleaner than they at first pretended to be. Persons with the bump of approbativeness highly developed constantly forge to the front on lines which they think will win

* One large mill has three lines of pipe, each over forty miles long.

them the esteem of their fellows, and the latter follow with unequal steps, first showing outward respect and conformity to better ideas and practices, and then making them more or less of realities in their lives.

Denunciation of hypocrisy forms a large part of the "properties" of lay and ecclesiastical moralists who exploit time-warped schemes of salvation. Exercise of moderate reasoning powers would teach them that calculating and persistent hypocrisy has been one of the most powerful factors in the moral advancement of the world. We all aspire higher than we attain, and in the moral domain pretense constantly precedes practice. We begin by appearing to be better than we really are, and the force of habit soon makes an actuality out of what was merely assumption. Hamlet explains this clearly to his mother:

> "That monster, Custom, who all sense doth eat
> Of habit's devil, is angel yet in this:
> That to the use of actions fair and good
> He likewise gives a frock or livery
> That aptly is put on. Refrain to-night,
> And that shall lend a kind of easiness
> To the next abstinence—the next more easy—
> For use can almost change the stamp of nature,
> And either quell the devil or throw him out
> With wondrous potency."

Those who pretend to be much better than they are have at least begun the upward development, and recognized the goal to which their faces should be turned.

No man is made worse by simulating goodness. There is every chance that he will be made better by the mere act of simulation.

Beyond doubt, the much-abused Pharisees were powerful promoters of the ethical development of the Jews. Their firm insistence upon higher moral ideas and purer lives could not have been without marked influence upon those around them. If the only motive for doing this was to enhance the esteem in which they were held by the community, it speaks well for their shrewdness in recognizing the drift of public sentiment, and for the community which honored superior goodness.

Jesus Christ's denunciations of them should be given the allowance usually accorded the polemic blasts of a sorely nagged sectary against his rival sectaries. If, indeed, they only cleaned the outside of the cup and platter, they certainly did much better than those who let both outside and inside remain foul. The very denunciation implies that this must have been the rule with those around them. If a man, seeking the applause of his neighbors, begins by furbishing the outside of his platter, in order to be superior to them, there is every probability that he will soon progress to the cleansing of the inside also, so as to still keep ahead of those who emulate him by external purification of their culinary utensils. Then their cleanliness as a principle becomes merely a matter of time.

National histories and the portraiture of the great men of the past are all more or less flagrant pieces of hypocrisy. The historians of every nation carefully feed its self-esteem by the assiduous elaboration of everything in its past that is noble, brave, and enlightened, and the equally assiduous obscuration of all that is mean, cowardly, barbarous, and otherwise discreditable. It is true that modern historians have abandoned the ancient practice of tracing the descent of their peoples directly from the immortal gods, but they come as near it as the limitations of modern thought will allow. Invariably they represent their people as of exceptionally distinguished lineage and character and a powerful factor for good from the moment of entrance upon the stage of history. Its soldiers were godlike in courage and devotion; its statesmen divine in purity and wisdom. Higher motives than desire to flatter the national vanity help to actuate the historians in this misrepresentation. They believe that it is best to make out of the past ideals for coming generations to emulate. They desire to stimulate national virtue by high examples.

The truth is, the early history of every great nation is like the early history of men who have risen from the gutter to prominence. There has been a long and dreary period of ignorant—frequently disreputable—struggling of mean abilities, in mean ways, with mean competitors and mean surroundings. Rightly viewed, this is one of the most comforting facts in human history, for it shows that nations, like men, constantly

> "rise to higher things,
> With their dead selves as stepping-stones."

Take, for example, the history of England. The impression which has been studiously produced upon the mind of the average reader is that that great nation has, ever since the advent of William the Conqueror (if not before), occupied the same proud place at the head of the wealth, power, and civilization of the world that she has for the past century. Nothing could be farther from the truth for at least four centuries after the battle of Hastings. Until usurper Henry VII snatched the scepter from the lifeless hand of usurper Richard III, on Bosworth Field, in 1485, England was a thinly peopled, out-of-the-way island, of almost as little importance to the rest of the world as Venezuela is to-day. Such ignorant, dull, brutalized white men as the Englishmen of the Plantagenet period are not to be found to-day outside of a Russian village, or a community of Hungarian miners in a Pennsylvania coal town. Then civilization shed but feeble light at its centers on the Continent, while the mongrel race in England were literally the "heathen of the isles," who dwelt in Cimmerian darkness. Nor, as historians would make us believe, was the high civilization which succeeded self-evolved from this unpromising horde. Native Englishmen—Norman and Saxon—played but a small part in the development of the nation. The men who made England were the swarming adventurers from every land—enterprising merchants, cunning artificers, and sailors bold—who flocked to the island when the discovery of the Cape of Good Hope and the Americas, together with the growth of northwestern Europe, made it the finest business location in the world. It gratifies the pride of the amalgamated descendants of those many-tongued adventurers to believe that they are sprung directly from the Anglo-Saxon lords of the soil, or from the "landless resolutes" who went filibustering with William the Bastard. The besotted peasantry found to-day in the purely agricultural districts of England indicate the intellectual sterility of the land before its splendid commercial opportunities caused it to be fertilized by a freshet of the best brains and energy of the Continent. The domestic peace which began with the Tudors was also potent in this enrichment, in attracting thither from the war-accursed mainland a large share of the intellect and skill of Europe. The few hundred thousand beef-witted Britons of the days of the early Tudors would have counted for no more in history than the Bretons of France, the Basques, or the Styrians, had it not been for the inundation of superior minds, moved to flow in from every quarter by love of gain, of peace, and of freedom of conscience.

"Lives of great men all remind us," if we examine them critically, that, since their day, the advance in morals has been almost as great as in the arts and sciences. Judged by present ethical standards, many great men of the past—the benefactors of their race, and men who builded strongly and well for their countries and the world—had the morals of the slums. Had they been held to the same accountability as the men of to-day, they would have been social outcasts, if not actually behind prison-bars.

Taking even our own country, and so recent history as that of the end of the last century, every well-informed man knows that the private lives and much of the public careers of the men whom we revere—such men as Winthrop, Hancock, Adams, Washington, Jefferson, Madison, Franklin, Monroe, Jackson, etc.—would not bear at all the tests we now apply to public and private characters. Yet we hypocritically assume that these men were altogether superior to any now before the public eye. We teach our children that they were ideal men, whose characters form the highest models for imitation. While this is arrant hypocrisy, it is probably wise public policy, and, after all, but justice to those illustrious men. Their morals were undoubtedly superior to the rule in their day. The good they did lives after them, while the evil is buried with their bones. Much, too, of the evil seemed good to them. As Froude well says, "All history is anachronism, for we constantly see the events of yesterday by the light of to-day." Nothing is to be gained by parading their weaknesses and vices, while much good is accomplished by presenting them as unblemished ideals—exemplars for present and future generations.

It is the same with our national history. Up to that time there was never a more genuinely patriotic struggle in the history of the world than our Revolution. Yet if the movement for independence had been deprived of all the aid given it by sordid greed, selfish ambition, industrious self-seeking, and partisan rancor, the patriotic impulse would have been far from strong enough to carry on the contest to final victory. But we wisely enrich human nature by placing to its credit all these baser metals transmuted into the pure gold of unselfish patriotism.

The elevation of woman to her present position from the degradation into which she had sunk during the long night of the dark ages was a slow and tedious work. Nothing aided in it so much as the arrant hypocrisy which took the form of mediæval gallantry. It became the fashion to show ostentatious deference to woman, especially if she had birth, youth, and some pretensions to beauty. At first hollow and specious to the last degree—thinly varnishing a bestiality so low that it was scarcely above that of a "bull" seal, who takes possession of all the "cows" that he can force into his rocky harem and defend against the lust of rival "bulls"—the bombast of idolatrous devotion, the shamming of respectful deference, the make-believe admission of superiority in manners, morals, love, and religion constantly came, by mere force of iteration, to approach nearer the reality. Even the coarsest-grained of the gluttonous and swilling boors who formed the body of the "gentle knighthood" became, through the habitual wearing of the mask, more genuinely appreciative of womanhood and more of a gentleman at heart. The women, on the other hand, for the same reason, became more elevated because of the factitious elevation assigned them, better informed as to what was due them, and more strenuous in exacting it.

Sir De Bracy, the "free captain," was quite capable, had he gained the Princess Rowena for his wife, of beating her "with a stick no larger than his thumb," as the old English law permitted, or of subjecting her to other and deeper indignities. But the requirement of ostentatious politeness in public would have operated to make him less of a tyrant at home, and this influence, extending through scores of generations, has assisted powerfully in securing for women all that they now enjoy. Even the Ivanhoes of the thirteenth century made fearfully tough husbands, and led their "queens of love and beauty" wretched lives; but still they had to make some show of living up to the gush and swagger of the tournament, and the women were better off than they otherwise would have been.

Millions have drifted into intimate relations with the bath-tub and clean linen who, at the outset, had no intention of going further than such superficial cleansing as would make a good impression on those around them whose favorable opinion it was desirable to have.

The traditional young lady who, notified that she was to go to a party that evening, called down the stairs to her mother to know if she were to wash for a high-necked or a low-necked dress, undoubtedly came in time to value cleanliness for its own sake, and make her ablutions without careful reference to the amount of surface her costume would reveal.

We shall go far, however, to find so good an illustration of the rapid development of pretense into actuality as is afforded by the history of religions. All religions began with shows, forms, and external observances, which, *per opere operato*, as the Catholics used to hold of baptism, speedily became faith. The conquerors, rulers, and soldiers who, for political and selfish reasons, imposed the Christian and Mohammedan religions on more than half the world, only attempted to compel extrinsic acceptance of their forms and ceremonies. What one generation did under the shadow of a sword which was quick to smite, succeeding ones did from what was considered the deepest religious instincts. Outward forms, which were terms of capitulation exacted by conquerors, quickly grew into symbols of true inward faith. Belief sprang from the reflex action of acts. Men did certain things to save their lives or property, and then fully accepted the spiritual meaning of those things. So long as Christianity relied merely on the teaching of its doctrines, it made slow progress indeed. Three centuries after Christ Constantine the Great, for political reasons, gave to it the powerful aid of the sword of state, and thereafter its spread was much more rapid. Still, it required more than one thousand years of bloody propaganda, by blade and fire, before its ascendency became acknowledged throughout the whole of Europe. By the end of the fourth century the energetic militarism of Theodosius the Great—frequently exerted by armies of barbarians—had nominally overthrown paganism throughout the Roman Empire, and nominally established not only Christianity, but the Nicene form of that faith. His successors devoted such leisure intervals as they could gain amid their swiftly following intrigues, accessions, assassinations, insurrections, invasions, and dethronements, to wholesale baptisms of Jews, pagans, and other non-Christians, so that the Church grew in numbers though the empire fell to pieces.

In the eighth century Charlemagne set about the work of evangelization on a grand scale, and for thirty-two years devoted the major part of the military resources of his empire to spreading the gospel among the heathen Saxons. He killed off possibly one hundred thousand of them—slaying forty-five hundred in cold blood at one time—and deported thousands of those he did not kill to other lands. Finally, their king and leading warriors had to bow before his puissant sword, and receive the rite of baptism. He also converted great numbers of Huns, Danes, Wends, Swedes, and Czechs.

Still a large portion of northern Europe was left under the control of the priests of Odin, and for several centuries the work of rounding up these pagans, and chasing them with blade and brand into the bosom of the Church, was a favorite occupation of princes and knights. At the end of the tenth century Olaf I succeeded in converting the Norwegians at the point of the lance, and his son followed up pagan-killing with such enthusiasm as to win himself canonization from the Church. Sweden was brought into the fold about the same time and by the same means; but it was not until the beginning of the thirteenth century that the Christianization of Denmark was completed by a grand raid of Valdemar II into Esthonia. Then the Teutonic Knights did some very successful missionary work, accompanied with much slaughter, in securing the supremacy of the Cross among the heathen of Prussia, Courland, and Livonia.

While mailed hands were thus persistently hammering the heathen of northern Europe into practicing Christian rites, the evangelization of Russia was brought about with less attrition—the Muscovites being a more submissive people. Toward the end of the tenth century Vladimir the Great decided that it was necessary to have a state religion. He studied the Jewish, Mohammedan, Roman Catholic, and Greek forms, and gave the preference to the latter. He had sixty thousand of his people baptized in one day, and the rest accepted the ordinance as fast as his agents could reach them and communicate his will.

Everywhere the result was the same. Outward compliance begat inward conviction, and the peoples whose stubborn necks were bent with most difficulty to the yoke of the Church became in time its sturdiest upholders. Hudibras says:

> "The man enforced against his will
> Is of the same opinion still."

Human history does not confirm this. On the other hand, it supports the assertion that if the enforcement is strong and continuous, the probability is that the enforced one's opinion will eventually coincide with it. With several volumes of standard reference books close at hand, I calmly await the vehement chorus of dissent from this proposition.

CULTIVATION OF SISAL IN THE BAHAMAS.

By JOHN I. NORTHROP,
OF COLUMBIA COLLEGE.

"ARE you interested in sisal? What do you think of it?" These were the questions addressed to the writer almost before he had landed in the Bahamas. The object of the writer's visit to the "land of the pink pearl" was to make a collection of its plants and animals; but, during the pleasant six months occupied in so doing, he had many opportunities of observing the cultivation of the "sisal hemp." This industry is now in its infancy in the Bahamas, but, if the present prospects are realized, it will before long bring to the islands both wealth and prosperity. Since his return the writer has found that most of those to whom he has spoken of sisal had at best but a vague idea of the fiber or of the plant that produces it, so it was thought that some notes on the subject might prove of interest.

The group of coral islands known as the Bahamas lies east of southern Florida and north of Cuba. One of the islands, New Providence, is well known to those who, in search of health or recreation, have been to Nassau and enjoyed its lovely winter climate. But the "out islands," as the remaining ones are locally termed, are seldom visited, even by those who live in Nassau. The largest of these "out islands" is Andros, which is about the size of Long Island, New York; there, as in all the others of the group, except New Providence, the population is almost entirely composed of negroes, only seven white men living on the island; and of these, four are interested in the production of the fiber known as sisal hemp.

The term "fiber" is used commercially to designate the material obtained from the leaves or stems of many different plants. Hemp, on the contrary, refers to the product of a single plant, known botanically as *Cannabis sativa*, and belonging to the same order as our hop. But in speaking of fibers the word "hemp" is often added, and thus we hear of "sisal hemp," or, as it is sometimes called, "sisal *grass*," or even manila. The latter term, however, is properly restricted to the fiber obtained from a species of plantain (*Musa textilis*), belonging to the same genus as the banana.

Sisal hemp, the subject of this paper, is obtained from the leaves of some of the species and varieties of the genus *Agave*, one species of which is well known in cultivation under the name of "century plant." This genus belongs to the order *Amaryllidaceæ*, and is related to the snow-drop, amaryllis, and narcissus; but, owing to the much greater size of the plants, and some peculiar points of structure, it stands prominent among its congeners. The agaves are indigenous in the New World only, and the majority of the species are natives of Mexico, only a few being known within the limits of the United States.

The same general appearance is presented by all, so that any one familiar with the century plant can form a very good idea of the appearance of the other species of the genus. In all, the leaves are thick and fleshy, as they contain the supply of material which is to nourish the great flower-stem when the plant arrives at maturity. This stem, which is a prolongation of the trunk of the plant, shoots up from the center of the rosette of leaves, and often attains a height of from twenty to thirty feet. The time required to arrive at maturity varies in the different species, and in the same species under different conditions. The "century plant" in its native home, Mexico, blossoms in from ten to fifteen years, while with us it requires thirty, fifty, or in some cases, it is said, even a hundred years to mature. During the production of the great flower-stalk the store of nourishment in the massive leaves is exhausted, and, after the fruit is produced, the plant withers and dies.

The leaves of all the agaves contain what are known botanically as the fibro-vascular bundles. In order to see these, it is only necessary to cut off a leaf of the century plant; as, in a thick transverse section, that has been allowed to dry slightly, the fibers will look like short bristles projecting from the surrounding soft tissue; and in a longitudinal section these bristly points are seen as threads running through the leaf. Should the observer be the fortunate possessor of a compound microscope, on examining these threads he will find them composed of exceedingly fine, elongated cells, closely connected in a bundle, and surrounded by the much larger circular cells that compose the soft parts of the leaf. When the outer skin and the soft tissue of the leaf are removed, the fibro-vascular bundles remain and constitute what is commercially known as "fiber."

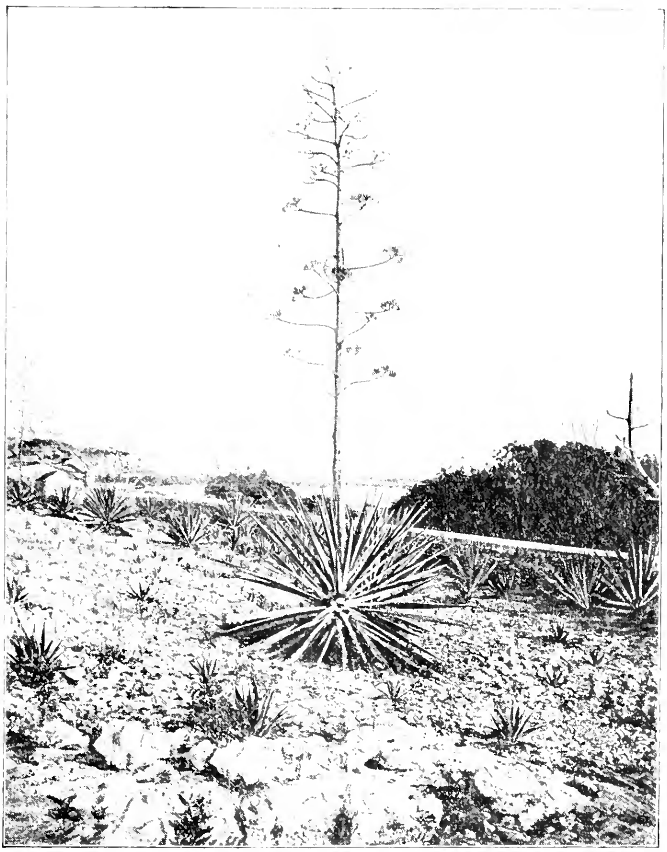
While all the agaves will yield fiber of some kind, it is only in a few that the quantity and quality of the material are such as to make its manufacture profitable. This fact has been known for a long time in Yucatan, the home of the sisal industry. There the natives have from time immemorial cultivated a number of agaves, until now it is difficult for botanists to decide whether some of them are distinct species or only cultivated varieties.

One of the native species, known as *Agave rigida,* is a rather small plant, having leaves from two to four feet long, and as many inches wide. These are armed on the edges with dark-brown spiny teeth, and are terminated by a stout, reddish-brown spine. This seems to be the plant called *chelem* by the natives of Yucatan, and is the one from which the cultivated varieties are supposed to have originated. These varieties, collectively known as *henequen* or *jenequen,* are separately distinguished as the "*yaxci,* furnishing the best quality, and the *sacci,* with the largest quantity of fiber; *chucumci,* larger than the last, produces coarse fiber; and *babci* has finer fiber, but in smaller quantity."

Of the varieties mentioned above, only two need be considered—the *sacci* and the *yaxci.* The former, known as *Agave rigida,* variety *longifolia,* is distinguished from the native plant by having much longer, spiny leaves, from four to six feet in length, and slightly different flowers. It is extensively cultivated in Yucatan, and, as already stated, yields the most fiber. The other variety, the *yaxci,* botanically dignified by the title *Agave rigida,* variety *sisalana,* or sometimes even elevated to the rank of a species, is one of the most valuable of the fiber-producing agaves.

The leaves are of a dull-green color, four to six feet long, as many inches wide, and terminated by a stout, dark spine. The margins are commonly described as smooth, as they are without teeth, but in all the plants examined by the writer the leaves were slightly rough on the edges, and in many of the young plants some of the leaves had well-developed teeth. A full-grown plant presents a rather striking appearance, bristling all over with the long, spiny-tipped leaves, thickly radiating from the short cylindrical trunk, which is crowned by a sharp, slender, cone-like bud. Indeed, a large plant makes one think of a gigantic sea-urchin. The leaves as they unfold from the bud slowly assume a horizontal position, but remain rigid and straight, never curving downward, as they do in the century plant.

As has been said above, when the plant arrives at maturity, and has a sufficient store of nourishment, it sends up its flower-stem, known to cultivators as the "mast" or "pole." This is from twenty to twenty-five feet high, and about six inches in diameter near the base. On the upper two thirds branches are developed, converting the pole into a huge panicle, covered with innumerable greenish-yellow flowers. A peculiarity of the sisal plant is that it seldom or never sets a seed. The flowers fall, carrying the ovary with them, then on the ends of the branches young plants develop, so that the pole presents a rather odd appearance, with the small plants growing out in the places usually occupied by the flowers. When these young plants have attained a height of from three to four inches, they fall to the ground and take root. The old plants also reproduce themselves by means of suckers, and hence, when old and neglected, are often seen surrounded by numerous smaller ones, as in the common houseleek (*Sempervivum*).

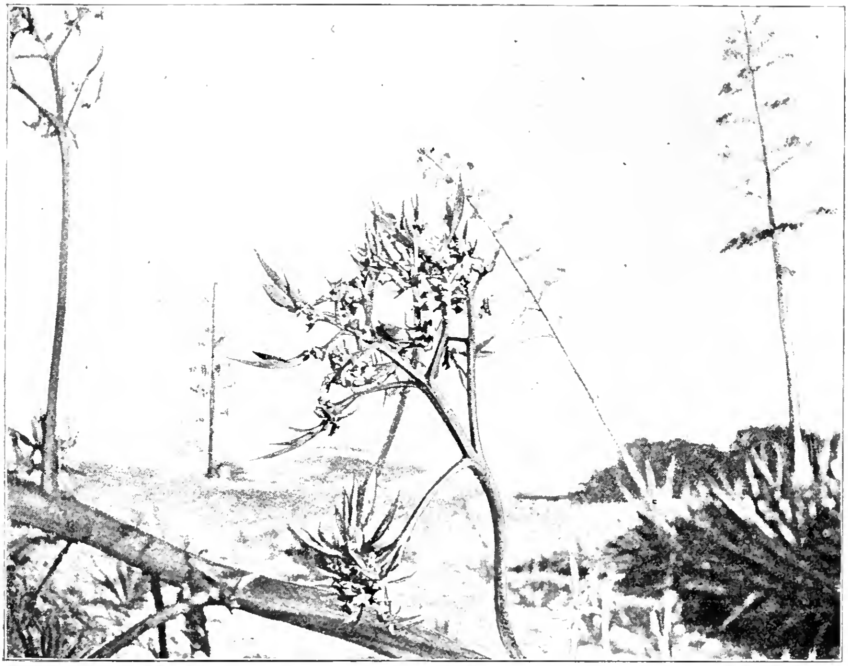


Agave rigida, VAR *sisalana*, IN BLOSSOM, NEAR NASSAU, N. P.

Such is briefly a general description of the plant that seems destined to occupy the capital and energies of the people of the Bahamas; for it was this plant that was introduced there a few years ago by Sir Henry Blake,* then governor of the colony.

* Governor Blake is generally credited with having introduced the plants. But as early as 1854 an agave was sent by the British vice-consul Baldwin from Florida to the Bahamas. It is not unlikely that this plant was the same as those introduced by Dr. Perrine into Florida.

Although the plants were neglected, they throve and increased to such an extent that finally the people looked upon them as troublesome weeds, and as such they were often destroyed. Their usefulness, however, was evidently appreciated by a few; for, as Sir Ambrose Shea, the present Governor of the Bahamas,



A Branch of the "Pole" of the Sisal Plant.

told the writer, he was one day passing the house of a native, when a piece of rope attracted his attention. On inquiring where he obtained it, the negro replied that "it growed in de yard," and showed the governor the plant, and explained the way in which the rope had been made. Now, Sir Ambrose happened to be a native of Newfoundland, and hence knew a good rope when he saw it; so inquiries were at once made, and the value of the plants was learned.

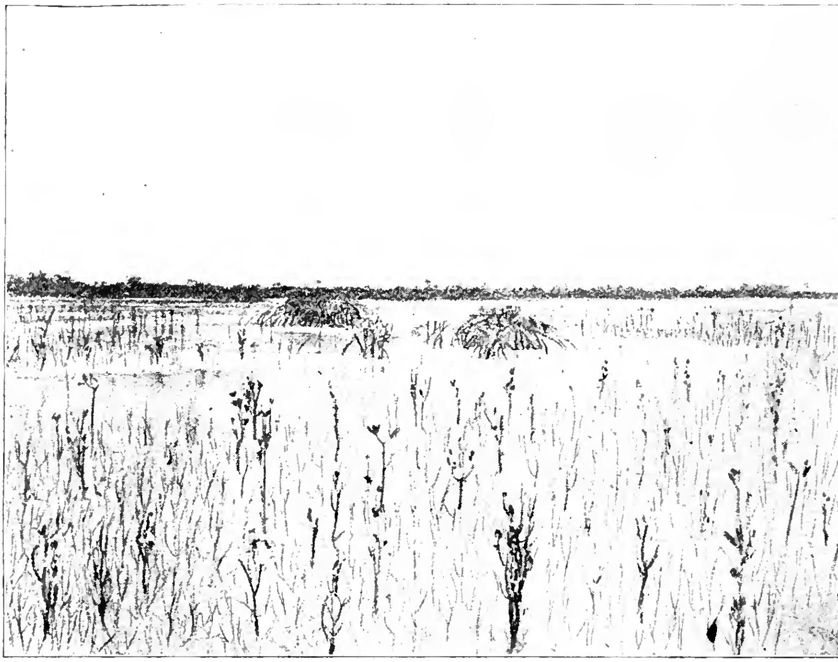
The people, however, were slow to realize the importance of the subject, but the governor evinced great energy and enthusiasm in keeping it before them, and when some of the fiber obtained from old plants sold in London at the rate of fifty pounds per ton, and was declared to be superior to that produced in Yucatan, sisal in the Bahamas had somewhat of a "boom," and people carefully guarded the very plants that formerly they would have destroyed as weeds. Everybody became enthusiastic, and sisal plantations were everywhere started, not only by the people of the colony, but also by outsiders, as the following facts show.

A company from St. John's, Newfoundland, has obtained a grant of 18,000 acres of crown land at Abaco; another tract of 20,000 acres on the same island has been allotted to a London company; 2,000 acres have been taken on Andros by a gentleman from Edinburgh; 1,200 are in process of cultivation on Inagua; but the largest application has been lately made by two London companies, who together ask for 200,000 acres. Besides the large plantations mentioned above, many small scattered areas go to swell the total. Indeed, there have been so many demands for crown land, that the governor has recently advanced the price from one dollar and twenty-five cents to four dollars per acre.

Now as to the character of the land. In Andros, which, as above stated, is the largest of the group, and where most of the writer's time was passed, the land is locally described by one of three terms: it is either "coppet," "pine-yard," or "swash." The coppet, which occupies, as a rule, the more elevated parts of the island, is composed of small angiospermous trees, often only two or three inches in diameter, and so close together as to make an almost impassable thicket. Back of the coppet, which is mostly a fringe along the eastern coast, nearly the whole interior is one vast "pine-yard," made up of the Bahama pine (*Pinus bahamensis*). The trees are generally small, and from ten to twenty feet apart. Under them is very frequently a dense undergrowth of a tall brake, which is often six or seven feet high, and is known by the natives as "May-pole."

"Swash" is a very expressive term to denote the low, swampy ground, of which there are thousands of acres on the west coast. Here the soil is soft and is composed of comminuted calcareous particles; it supports no vegetation except innumerable small mangroves (*Rhizophora mangle*), here and there small "button-woods" (*Conocarpus erectus*), a few "salt bushes" (*Avicennia nitida*), and in some places palmettoes. So far as sisal cultivation is concerned, the "swash" is utterly valueless; but the "pine-yard" and coppet are both available. In neither of these, however, is there what we recognize here as "soil"; and at first it was a source of wonder to the writer that anything at all could grow there, for the surface is very largely the bare coral rock. However, it is rarely smooth, but is rough and jagged with innumerable points and crevices, so as to resemble somewhat the appearance of a well-thawed mass of snow-ice. In most places, also, there are numerous holes, from a few inches to many feet in diameter; and it is in these holes, cracks, and crevices that what little earth there is can be found—still, this little seems sufficient to support the dense vegetation. Some of the other islands—Eleuthera, for instance—have considerable depth of soil; but it is when growing on the bare, rocky ground described above that the sisal is said to produce fiber of the best quality.

Given the land, the next step is to clear it, and the method of clearing varies according to the character of the vegetation. If



"Swash," West Side of Andros.

it is "pine-yard," a fire is started, which burns off the May-pole: the pines are then cut down, and either made into charcoal or laid in rows across the fields and allowed to decay; if coppet, the trees and shrubs are cut down with axes or cutlasses, according to their size, and the brush is then burned.

While his land is being cleared, the planter should be getting his plants ready. As usually obtained, they are fresh from the "pole," and only from one to four inches in height. These are too small to put out in the fields, so they are set out in beds of cave earth until they get to be eight or ten inches high. When taken from these nurseries their rootlets are carefully trimmed off, and they are then planted every eight or nine feet in rows that are about ten feet apart. Thus an acre of ground usually contains from five to six hundred plants. In order to facilitate carrying the leaves out of the field, the latter is divided by roads into sections of about one hundred acres each.

After planting, it is not very long before the fields will have to be weeded, and this process is said to be necessary about twice a year, until the sisal plants attain a height of three or four feet, when weeding is no longer needed. The most troublesome enemy of the planter, in the way of weeds, is the "May-pole," as it grows very rapidly, but the roots are said to die after the third cutting. In about four years the sisal plant produces what are called "ripe leaves"—that is, leaves that are horizontal and large

CLEARING THE "PINE-YARD" FOR SISAL NEAR NASSAU, N. P.

enough to cut. The cares of the cultivator are now about over, and all he has to do is to cut off the leaves as fast as they mature, and manufacture his fiber.

The cultivation of sisal is of such recent introduction into the Bahamas that as yet none of the large plantations have begun to produce to any extent; so for a description of the next stages we will turn to Yucatan, where, as has been said, the industry has been carried on from time immemorial. There the men cut the leaves off close to the trunk, and lay them tip to butt in bundles of fifty, when they are carted to the machines. The cutting of thirty bundles, or fifteen hundred leaves, is considered a good day's work. In order to save the cost of transportation, as the leaves yield but about five per cent of fiber, there is usually a machine to every one hundred acres. The machine now in use consists of a horizontal wheel, on the face of which brass strips are transversely placed, forming dull knives. The leaf is introduced so as to bring one side in contact with the revolving wheel, which is run by a small engine. A brake then presses the leaf against the scrapers, while the butt is firmly held by a pair of pincers. The scrapers remove the outer surface and some of the soft tissue; then the leaf is taken out and turned, and the other side undergoes the same operation, until only the fibers are left. These are then shaken out and hung in the sun for a few hours to dry. The result is a rather coarse fiber of considerable strength. The finest quality is nearly white, while the inferior grades are yellowish in color. In order to produce the best quality of fiber, the leaves must be cleaned as soon as possible after being cut; otherwise the fiber is apt to be spotted.

It may be well to state here that the cultivation of sisal is also being tried in Bermuda, Trinidad, and Jamaica, but on a much smaller scale than in the Bahamas. There, as already stated, large tracts of land have been bought from the Government for the sole purpose of producing the sisal hemp. The price is now four dollars an acre, and two acres are said to produce one ton of fiber. Wages for men vary from thirty-six to sixty cents per day, according to the season and locality, as most of the negroes are spongers, and at certain times of the year labor is not easy to obtain. Women, however, are largely employed in the planting and weeding, and receive on the average twenty-five cents a day. These are the data on which it is stated that a ton of fiber can be produced for fifty dollars. As the price of the fiber is now from one hundred and twenty to one hundred and thirty dollars a ton, and has been as high as two hundred dollars, these figures look attractive.

But it may well be asked, "How about the quantity of fiber now on the market, and will the market stand the enormous increase, that the yield of the Bahamas will give?" That is, of course the very point on which the question of profit or loss will turn. The writer has been told, by one who is well acquainted with the fiber market, that if the sisal hemp could be sold for four and a half or five and a half cents per pound, in a few years the consumption would be doubled; for, when the price reaches nine or ten cents a pound, the use of the fiber for many purposes is abandoned, and is replaced by some cheaper material, as jute.

One of the principal obstacles in the way of cheaper fiber is the need of a good machine, as the one now in use is a crude affair, requiring the attendance of two men and a boy besides the engineer, and producing but a small quantity of fiber daily. Although much skill and money have already been spent in attempting to invent a better machine, as yet all efforts have been unsuccessful; but, as inventors and mechanics are still at work, and as the recent "sisal boom" in the Bahamas will increase the demand, there is little doubt but that here, as in so many other cases, necessity will prove the mother of invention. When the fiber can be cheaply produced in large quantities, there is little doubt but that increased uses will be found for it, and that the demand will equal the supply.

THE HOUSE OF A SISAL PLANTER, ANDROS.

In 1887 Yucatan exported crude fiber valued at over \$3,000,000, besides \$37,862 in rope and \$43,891 in hammocks. About eighty-four per cent of the crude fiber and fifty per cent of the hammocks came to the United States; most of the remaining fiber went to England, Germany, and France, while Spain took the rest of the hammocks and all the rope. In 1889 the import of sisal hemp into the United States was between \$6,000,000 and \$7,000,000, about 50,000 tons, on which a duty of fifteen dollars a ton was paid.*

Now it may be asked, "Why can not the United States produce sisal too? Is no portion of our vast territory suitable for this crop?" As we shall see, some one *did* ask that question over fifty years ago. It is not generally known that in 1827 the Treasury Department issued a circular to some of the American consuls, requesting them to collect and preserve seeds and specimens of

* The duty has since been removed.

such plants in their districts as were "useful as food for man or the domestic animals, or for purposes connected with the manufactures or any of the useful arts." The American consul at Campeche, Dr. Henry Perrine, responded to this call with energy and enthusiasm, and soon introduced into Congress "a bill to encourage the introduction and promote the cultivation of tropical plants in Florida, and conveying to Dr. Perrine and his associates a township of land, on condition that every section should be forfeited if at least one fourth thereof should not be occupied and successfully cultivated in tropical or other plants within five years." These hard conditions were accepted by Dr. Perrine, and in one of his letters to Congress he calls attention to the sisal plant, and says, "He repeats his unbroken conviction that its introduction will make an era of as great importance to the agricultural prosperity of our confederation as the invention of the cotton-gin."

For nearly ten years he labored, sending to Florida plants and seeds, and endeavoring to obtain his township of land, desiring "no more honor than the power of passing the brief term of his painful existence amid the privations and exposure incident to a chief pioneer in the planting and population of tropical Florida." He finally succeeded in establishing a sisal plantation on Indian Cay. Unfortunately, Dr. Perrine was not permitted to see the result of his labors, for, during the Seminole War, the Indians set fire to his buildings, and he himself fell a victim to their merciless attack. With the death of Dr. Perrine ended the cultivation of the plants he had introduced; but one of them, that he named *Agave sisalana*, remained, became naturalized, and is now flourishing on some of the Florida Keys, where the young plants are now being gathered and carried to the Bahamas.

Thus we see that the plants are growing within our borders, and it is only necessary to determine the quality of their fiber; for, although the plants are the same species as those now cultivated in Yucatan and the Bahamas, the quality of the fiber may not be as good, and yet on the other hand it may be better. For instance, it is said that the Bahama fiber is superior to that produced in Yucatan; so why may not the "Florida fiber" of the future surpass that of the Bahamas? In order to determine its value it is only necessary to prepare it by hand from the plants now growing in Florida and compare it with the article now on the market. The subject is being investigated by the Department of Agriculture, and a report may be looked for in the near future.

It may be said in conclusion that, as a crop, sisal has much to recommend it. It grows best on barren, rocky land that is useless for other agricultural purposes. Drought affects it but little, if at all, as the writer can testify from his own observation. The yield is not confined to any one season, but is continual; hence the employment of labor is constant, and the planter can estimate closely what the yield will be for a given time. The old plants are easily replaced by the suckers that have been previously cut off and kept for this purpose. These advantages are shared by all the cultivators of sisal; but, in addition, the planter in Florida will have at his door a market that now absorbs eighty-four per cent of all the fiber produced. He will not only bring into use land now almost worthless, but will probably make for himself a fortune and introduce a new industry into the United States.

DR. KOCH'S METHOD OF TREATING CONSUMPTION.*

By G. A. HERON, M. D., F. R. C. P.

GENTLEMEN: This demonstration is given at the request of my friend Dr. Koch, who desires that in London and elsewhere his method of treating tuberculosis should, so far as is at present practicable, be open to the inspection of the medical profession. Certain parts of this work are already established upon a basis of clinical observation. Other parts of it remain still to be worked out. I think practically all that is yet known to be of consequence in the work is stated in Dr. Koch's paper, which was published in Berlin on the 14th of last month—a paper which has excited more wide-spread interest than any other contribution to medical literature. As a matter of course, you are all familiar with the details of the paper, and I propose to do no more to-night than to touch briefly upon those parts of it which it seems to me are essential to the understanding of the method of the administration of the remedy to our patients, and to a clear apprehension of the obvious results which follow its use in human beings.

The mode of action of the remedy within the body is not yet fully known. This much, however, is certain: tubercle bacilli are not destroyed by it in the tissues. It is upon the living tubercular tissues encircling the tubercle bacilli that the remedy produces its effect, and Koch says of this action that there is, "as is shown by the visible swelling and redness, considerable disturbance of the circulation and, evidently in connection therewith, deeply seated changes in nutrition, which cause the tissue to die off more or less quickly and deeply, according to the extent of the action of the remedy. . . . To recapitulate," he goes on to say, "the remedy does not kill the tubercle bacilli, but the tubercular tissue; and this gives us clearly and definitely the limit that bounds the action of the remedy. It can only influence living tuberculous

* Address delivered at the City of London Hospital for Diseases of the Chest, December 1, 1890.

tissue; it has no effect on dead tissue, as, for instance, necrotic cheesy masses, necrotic bones, etc., nor has it any effect on tissue made necrotic by the remedy itself."

In dead tubercular tissue living tubercle bacilli are often found. If the organisms so situated do not escape in some way from the body, they may find a nest for themselves there, and so set up fresh centers of tubercular disease. This fact clearly indicates that the treatment of tuberculosis by this new remedy must be continued for some time. From what is now known, it seems likely that about six weeks will be required to rid patients in the early stage of consumption of the symptoms of their disease. Whether this does or does not mean the complete cure of the disease is at present a question which will be answered conclusively by patients treated in hospital wards. It is in the highest degree probable, as every bacteriologist will understand, that relapses will occur. They must be treated on the principles already laid down by Koch, and their importance as a factor in the ending of the case must be worked out in public hospital practice. This I can say concerning the success which attends the use of this remedy in tuberculosis. I have never seen in a considerable series of cases treated by any remedy such uniformly good results, nor results so favorable to the patients. I do not, in what I have just said, include cases of advanced lung tubercle. Of that class of patients I have seen too few treated in the new way to entitle me to speak of them from my own knowledge. What we have heard and read of such cases in connection with this treatment leads us to expect at most temporary amelioration of their condition. Attention can not be too forcibly drawn to what Koch says, in his paper of November 14th, concerning the grave responsibility which will in future rest upon medical men, who leave any means untried to diagnose tubercular disease in its earliest stages. To that end the examination of the sputum ought, he says, to be much more frequently practiced than it is to-day in Germany. Speaking from an experience in that direction which is not small, I venture to say that this remark of Koch's applies with at least quite as much truth to England as to Germany. Now that we have the means, in this new remedy, of holding out to our patients who are in the early stages of tuberculosis—whatever form the disease may assume—the highest probability of a cure of their condition, it will, in my opinion, be a very grave reproach to any medical man who neglects to make an early diagnosis of tuberculosis, and, having done so, postpones needlessly the systematic use in those cases of Koch's remedy.

Koch has said that the action of his remedy consists in the destruction of living tubercular tissue. The destroyed tissue must be thrown off or absorbed. We might, perhaps, feel uneasy as to the consequences of this, even in some cases of lung tubercle in its early stages, and especially in tubercle affecting the larynx, where the swelling, which is part of the effect of the remedy, might conceivably prove dangerous. Experience has, however, shown that, in the considerable number of such cases already treated, no serious risk has arisen. It is a fact that the mucous membranes of the tubercular larynx, while under this treatment, do not swell to such an extent as to interfere very seriously with respiration. Even in advanced cases of lung tubercle, with excavation of considerable portions of lung tissue, there have been no ill effects from the treatment when it has been conducted with careful attention to the regulation of the dose of the remedy.

The remedy is a transparent, reddish-brown fluid, not unlike brown sherry in appearance. It has no sediment, and when undiluted does not readily decompose. When diluted with distilled water it is, on the contrary, apt to decompose. Bacterial growths quickly appear in it, and it becomes turbid. In this condition it is unfit for use. Its decomposition in dilution is prevented by boiling it, but that process is not necessary if the dilution be made with a half-per-cent solution of carbolic acid in distilled water. It should be remembered that both by the frequent boiling of the dilution, as well as by the mixing of it with carbolic acid in the way described, the vigor of action of the remedy is impaired, and therefore fresh dilutions ought only to be used. Experience has, however, shown, I am told, that a one-per-cent dilution of the remedy made with distilled water containing one half per cent of carbolic acid remains efficient at the end of one week. The remedy is introduced into the body subcutaneously by means of a syringe which Koch devised for his bacteriological work. It has no piston or washers, and consists of four parts—an India-rubber ball, with a small hole in it. This ball is fixed upon a hollow metal stem furnished with a stopcock; into the other end of the metal stem there fits a glass tube, pointed at the farther end, and graduated to one cubic centimetre, each division representing a milligramme. Upon the pointed end of the glass tube there fits a hollow needle. In using this syringe the glass tube, with the needle affixed, is detached from the metal stem and filled with absolute alcohol. The metal stem and ball are then replaced in position, and the alcohol gently expelled. Every day before using the syringe I think it well to disinfect the metal stem and the India-rubber ball. Alcohol, however, causes cloudiness in the dilutions of the remedy, and therefore it is necessary to get rid of it as much as possible. For that purpose I wash out the syringe with a little distilled water.

The dose of the remedy has been sufficiently well fixed for all practical purposes. In a healthy man, 0·25 c. c. produces an intense effect. Koch thus describes the symptoms produced by that dose on himself, after it had been injected into his upper arm: "Three to four hours after the injection there came on pain in the limbs, fatigue, inclination to cough, difficulty in breathing, which speedily increased. In the fifth hour an unusually violent attack of shivering followed, which lasted almost an hour. At the same time there were sickness, vomiting, and rise of body temperature up to 39·6° C. (103·3° Fahr.). After twelve hours all these symptoms abated; the temperature fell until next day it was normal, and a feeling of fatigue and pain in the limbs continued for a few days, and for exactly the same period of time the site of injection remained slightly painful and red."

One c. c. of a one-per-cent solution—that is to say, a dose of 0·01 c. c. of the remedy—is the smallest dose which affects healthy adults, and the symptoms, more or less marked, following its administration are, in the majority of cases, slight pain in the limbs and a sense of transient fatigue. Only a few persons after this dose show a rise of temperature up to not more than about 100° Fahr. The word "reaction" is used to indicate the symptoms, mild or severe, which follow upon the use of the remedy. In non-tuberculous adults there is no real reaction consequent upon the administration of any dose of the remedy less in amount than 0·01 c. c.; therefore, the presence of reaction in the adult after a dose of less than 0·01 c. c. of the remedy shows the presence of tubercle in the patient. If in the adult no reaction were obtained by any dose short of 0·01 c. c., then it would be certain that the case in question was not one of tuberculosis. This is a law to which no exception has hitherto been found, and it gives the remedy great diagnostic value, which, it seems likely, will be one of its most useful clinical applications. The law applies to both man and beast, and to all tubercular conditions. Already cases have occurred in which the presence of tuberculosis was not even suspected until the remedy was injected and reaction followed.

The dose of the remedy is regulated in tubercular cases by the age and strength of the patient, and by the conditions of his disease. In children and weak people, and in cases of very extensive disease of the lungs, the treatment should begin with the smallest effective dose, which should be very gradually increased. In fairly strong adults with lupus, joint or gland disease, and also in cases of lung tubercle, where the disease is slight in extent, or where the case is doubtful, a full dose of 0·01 c. c. may be administered with safety. But in lung disease, however slight or otherwise favorable the case may be, it is well to begin with a much lower dose. The difference in the conduct of the treatment of lung tubercle and of lupus is that the former is treated with small doses daily, and the latter with large doses at intervals of one or two weeks. Tuberculosis of joints, bones, and glands is treated in the same way as lupus.

A first dose in early cases of lung tubercle in an adult should be either 0·001 c. c. or 0·002 c. c. If reaction follows this dose, then it should be repeated after the temperature has returned to the normal point. The same dose should be continued in this way until no reaction follows its use. The dose should then be increased by one, or at most two, milligrammes at a time; each dose being repeated until it is found that no reaction follows its administration, and so on until the dose of 0·01 c. c. is reached. The dose of the remedy should never exceed 0·01 c. c., except as a test to ascertain whether the utmost limit of benefit to the patient has been secured, and this test should be applied to every case. The duration of the treatment in early cases of lung tubercle Koch states to be, as I have already said, from four to six weeks. If after the administration of test doses of the remedy no evidence of the presence of disease is noticed, then the case, Koch says, may "be pronounced cured." I repeat, this statement refers to early lung tubercle only.

As regards the immunity from tuberculosis which may be enjoyed by the human patient after such a course of treatment, no evidence, so far as I know, has yet been brought forward concerning it in clinical records from hospitals, though the protective power of the remedy has been established as a fact by Koch's experiments as regards beasts. The doses of the remedy are prepared as follows: Two dilutions of the fluid are in general use, a one-per-cent dilution and a ten-per-cent dilution. The one-per-cent dilution is prepared by putting 0·5 c. c. of the remedy into a glass vessel graduated up to 50 c. c. The vessel is then filled up to 50 c. c. with distilled water containing a half per cent of carbolic acid. One c. c. of this solution contains a dose of 0·01 c. c. of the remedy. Koch's syringe is graduated in milligrammes up to a capacity of 1 c. c.; therefore, if 1 c. c. of this one-per-cent dilution be placed in that syringe, each marked milligramme of it will contain a dose of the remedy equal to 0·001 c. c. The ten-per-cent dilution is used exactly in the same way as the one-per-cent dilution. Every milligramme of it contains 0·01 of the remedy, and by means of this stronger dilution the larger doses may be given, or, by dilution, any less dose that may be needed. The subcutaneous injection of the remedy is made in the skin of the back, between the shoulder-blades and the spine, or near the lumbar part of the spine. These parts are selected for this purpose because they are less sensitive than most parts of the skin, and because absorption takes place very quickly from their neighborhood. Before giving an injection the skin around the proposed site of puncture should be disinfected by means of a 1 in 40 dilution of carbolic acid. The needle should also previously to its being used be dipped in a 1 in 20 dilution of carbolic acid.

The reaction in tubercular cases consists in a gradual rise of temperature, beginning three to five hours after the injection. In ten to twelve hours it reaches its acme—namely, a temperature of 102° to 104° Fahr. It may even rise as high as nearly 106° Fahr. Shivering often occurs as the temperature rises, but it is not a constant symptom. Pains in the joints, increase of cough and expectoration, nausea and vomiting, headache, often frontal in position, and great prostration and drowsiness, sometimes deepening into stupor, are the symptoms of the reaction. In one instance a man who was tuberculous continued in a state of stupor for forty-eight hours after receiving a dose of 0·01 c. c. Slight icterus and a general papular eruption, which has been so very well described by Dr. Radliffe Crocker, in his paper in The Lancet of November 22d, are among the less frequent symptoms which follow the injection. The fever lasts, as a rule, for from fifteen to twenty-four hours, and is accompanied by an increase in the rate of the pulse and of the respiration. The fever gradually declines, and the temperature falls to subnormal, but often rises again to about 100° Fahr., less or more, and then gradually drops to normal. The patient, as a rule, suffers but little after the fever. Cases of lupus best show the local reaction, but, as Dr. Koch has perfectly described all that is meant by the local reaction, it is needless to trouble you now with a repetition of his words. I have also a case to show you which illustrates sufficiently well the early action of the remedy on lupoid tissues.—*Lancet.*

THE TYRANNY OF THE STATE.

By SAMUEL WILLIAMS COOPER.

THE duties of the individual to society, particularly in the crowded centers of the world, become every day more numerous and burdensome. Thousands of bulky volumes do not suffice to contain the common law, the codes, and the countless decisions under the same on this subject. The taking of human life and the throwing down on the street of a piece of waste paper are alike punishable as crimes. If two or three gather together on the corner of a public highway to discuss the many obligations they owe to the sovereign power, and raise their voices loudly, the state, in the form of a blue-coated officer, orders them off, and, if any objection or answer is made, clubs them to the station-house.

Thereupon the state becomes the accuser, the witness, and the judge, and, without an opportunity to be heard or to call witnesses in defense, the offenders are held to await trial. Should any one become disgusted with his duties as a citizen and attempt to end his misery, if caught in time, he may be punished as an abandoned criminal.

Amid this never-ending round of obligations the nature and limits of the authority that imposes them is a question seldom stated, yet it must be recognized as one of vast importance to mankind. The axiom that the people do not need to limit their power over themselves has been used to quiet all complaints, and the patients have gradually become stupefied by their own wisdom. There would seem to be an ever-increasing inclination on the part of the state to unduly stretch its rights over the individual—both by careless legislation and by indifference to its solemn obligations.

It is true, that to read the Scriptures in English or to speak against the Prayer-book is no longer a capital offense, nor are innocent old ladies executed at Salem for witchcraft; but personal liberty and the rights of property are constantly violated, and the citizen is utterly without redress. The comfort administered in monarchies to those who complained on this score was that the king could do no wrong; but a few years ago the Supreme Court of the United States declared that this doctrine had no place in American jurisprudence. This enunciation of a democratic feeling was, however, mere emptiness; for, in other cases before the same tribunal, it has been held as axiomatical that the sovereign power is free from all legal duties. Law, it is said, is a rule of action laid down by a superior; and the state can not be said to be in subordination to itself, excepting so far as it may choose to part with its sovereignty.

For many years the only redress against the United States for wrongs done by it was by bringing the injuries to the attention of Congress. Latterly the Court of Claims has been established, but has jurisdiction only to hear cases that arise out of contracts made within six years from the time suit is brought. For those older than this—for all sorts and the vast variety of claims that may arise, other than for mere money demands—the sole redress is still before the legislative body. It would take a series of volumes almost as great as those containing the duties of the individual to the state to recount the tales of robbery and outrage on the part of the national Government that appear in the appeals for justice now on record at Washington. Had these same acts been committed by private bodies, the united wrath of the people would have exterminated the offenders.

For goods or lands wrongfully taken by the officers of the

United States, although absolutely necessary for the support of the sovereign power, there is no liability; and if the claim is on contract, it must be shown to have been made with an officer authorized by statute to enter into the particular agreement. Although the claimant has been wrongfully kept out of his own for years, and finally recovers a judgment, the United States calmly tells him that it never pays interest on its debts (United States *vs.* Bayard, 127 United States Reports, 251); yet if it has a claim against a citizen who is insolvent it demands every dollar of it, with interest, before any other creditor can be allowed a cent (Brent *vs.* Baule, 10 Peters, 596). An action of ejectment for land taken by the Government will not lie. The officers who committed the act may be liable, but a judgment against them does not bind their principal (Carr *vs.* United States, 98 United States Reports, 433). The States are prohibited from passing any laws impairing the obligations of contracts, but the United States still reserves the power to itself of doing such wrongs (Evans *vs.* Eaton, Peters C. C., 323). The contracts with the Indian tribes are sad examples of this fact. Treaty after treaty of the most solemn kind, founded upon considerations of money and the deepest morals, has been violated with as much indifference as a man would brush a fly from his body. So the Supreme Court of the United States has declared that, notwithstanding the prohibition on the States, they may violate those contracts at will that they have made with the citizen, or by laws framed to protect his health, morals, education, good order, or the public safety. The elasticity of these words, as stretched by the judges, is greater than any lexicographer could have supposed them capable of. The injustice is not so much in the decisions on this point, however, as in the results—not so much in the wrongs done to the individual, that are often necessary—but in the failure of the state to provide any compensation for the injuries.

For example, the various prohibitory or high-license laws have had the direct effect, in countless instances, of taking the property of the individual and wrecking his life and business, yet leave him without redress. It has happened innumerable times that men who have spent enormous sums in enterprises connected with the manufacture and sale of liquor, in States which by their laws encouraged them, have been deprived of every dollar by subsequent legislation. In Pennsylvania, under the recent license act, property to the value of millions of dollars was destroyed, the future of many good citizens was ruined, and some were driven insane and committed suicide. These were engaged in a traffic made lawful by the State laws, and in many instances there was not a word of complaint as to the moral character of the applicants. The Supreme Court of the United States has sustained such enactments on the ground that they are an exercise of police power, of the correctness of which, except in extreme instances, the State is the sole judge (Light Company *vs.* Heat Company, 115 United States, 650). To such an extent has this ruling been carried, that an act under which the sheriff was authorized to take possession of and destroy the contents of all liquor establishments, without making compensation, was held constitutional (Mugler *vs.* Kansas, 123 United States, 623).

There are bigots who will claim that this is a proper punishment for those who have been wicked enough to sell intoxicating liquors. These we refer to a late decision of the United States Supreme Court, arising under a statute of Pennsylvania in regard to oleomargarine (Powell *vs.* Pennsylvania, 127 United States, 678). In this case a citizen, a Mr. Powell, upon the faith of the two acts of Assembly that recognized the right to manufacture and sell oleomargarine, if properly stamped, spent a large sum of money in the erection of a factory. Subsequently another law was passed making it a misdemeanor to manufacture or sell such goods in any form. It was admitted that the food was perfectly healthful, cheaper than regular butter, and that it had been stamped as required by the earlier acts of Assembly. Despite this, the conviction of the citizen was sustained on the ground that the act was within the police power of the Commonwealth. It was held that it might be made a crime to sell any of the goods, because, if improperly manufactured, they would be injurious. As Justice Field, in a long dissenting opinion pointed out, almost every article of food on like grounds might thus be prohibited.

Could a greater outrage have been inflicted on a citizen? The State passes laws that provide for the manufacture and sale of a commodity; then, after the business has been established, makes the citizen a criminal who put his capital into it at its invitation. To produce a cheap, wholesome food would seem to be deserving of commendation rather than a prison cell. It is not necessary to read the dissenting opinion to be convinced that such a statute deprives the citizen of life, liberty, and property without due process of law. What should be said of a private person or corporation that committed the crime of inducing another, by false promises, to invest his all in a business acknowledged to be beneficial to mankind, and then deprived him of it and put him in jail?

To multiply cases on this point would be to detail outrages. The ruin that has been brought upon countless thousands can never be fully told. The power of the Government on such questions may be admitted to be absolute and necessary for control and good order; but, even so, the few should not be made to bear the burdens of the many without compensation.

The right of taking private property for public use is an incident to the sovereignty of every government; eminent domain, or inherent sovereign power, gives this control to the legislature—the interest of the public is deemed paramount to the individual, but the obliation is concomitant that in the exercise of the right full compensation shall be made. This is a fundamental doctrine, founded on national equity and a principle of universal law. As we have seen, however, there is a distinction made between property taken by right of eminent domain and that taken under the police power. In the former case just compensation must be made, in the latter none, although the act prohibited may have been lawful under previous statutes. There would seem to be no just reason for this difference. In either case the individual suffers for the benefit of the state. Indeed, in the exercise of the latter power the injury is often greater, in that it is unexpected, and hence can not be provided against.

Again, in the case of a contract made by a State directly with her citizens, as in the issue of bonds for the raising of revenue, there being no remedy by a suit against the State, the contract is substantially without sanction except that which arises out of the honor and good faith of the State itself, and these are not subject to coercion (Louisiana *vs.* Jumel, 17 Otto, 711). And although the State may, at the inception of the contract, have consented as one of its conditions to subject itself to suit, it may subsequently withdraw that consent and resume its original immunity without a violation of the obligation of its contract in the constitutional sense. Thus the State of Louisiana entered into certain engagements with her creditors; she embodied them in the most solemn form in her statutes and in her organic law; she provided for the levying of a tax to pay them; she prescribed certain duties for designated officers to perform in their collection and disbursement; she declared that no further legislation should be necessary for the collection of a tax or the appropriation of the proceeds, and that for the collection of the tax the judicial power should be exercised whenever necessary. In spite of all these seeming obligations and safeguards the Supreme Court, by a divided bench, decided that there was no power to stay repudiation. Substantially the same decree was made in the Virginia tax cases (*exparte* Ayres, 123 United States, 443). In these instances the States, after entering into the most solemn obligations with their citizens, deliberately and openly violated every principle of honor and good faith. To say nothing of the infamous wrongs inflicted, the influence of such actions on the morals of the people must be widespread.

The complications arising under the divorce laws of the various States have been dwelt upon at length of late by various writers, and a full discussion of the subject here is unnecessary. Attention, however, may be called to the fact that a citizen who fails to observe the nice distinction laid down may find himself a vile criminal, with illegitimate children, because he failed, when the marriage ceremony was performed, to cross a river or step over a border line. This neglect of uniformity is a crime on the part of society toward its members that in this age of the world should not be tolerated.

Again, take the instance of a man accused by the state of crime who is innocent. All the power of the social body is exerted to make him out a criminal. He is put to enormous expense in the employment of counsel, the obtaining of evidence, and all the incidental expenses of a trial; his business may be broken up, and his hopes and happiness in life wrecked. Yet, even if he is proved innocent, the whole burden falls on him, for the state makes no compensation for mistakes. At the last session of the American Bar Association a resolution looking to the correction of this evil was presented and referred to a committee, and it is to be hoped that the influence of this body may not be without effect. The forms of verdicts should be modified so as to express fully and distinctly the guilt or innocence of the accused, and in cases where it is clear that the defendant is entirely without blame, he should be compensated for the wrong done him.

If the citizen is convicted of crime, what shall be said of his treatment? He is looked upon as one who has run contrary to the currents of society and involved it in disorder; yet, truly, he is rather an index of the civilization that holds him. He has fallen, not because he was worse than his fellows, but because bad influences surrounded his weaknesses. Between those who are out and those who are in there is often no more than the thickness of the prison doors. But the fact that a criminal who is caught is safely confined is deemed enough; his reform is a matter to which the state pays but small attention. How little has been done the records speak. In some places the unfortunates are bound in chain-gangs and hired out as slaves; in others, they are driven insane by solitary confinement; and, again, the young and innocent are herded with vicious age. For these wards of the state, for whose condition it is largely responsible, there is seldom any effort at improvement. Yet the thoughtful man will find in the study of criminals and their ways the courses of crime, and a partial solution of the problems of social disorder. There should be an opportunity given them to work out their freedom under conditions more hopeful than those found in the confinements of our prisons.

Almost all the States have provided in their Constitutions that no human authority shall interfere with the rights of conscience.

Yet no citizen will be allowed to give evidence in a court of justice who does not profess belief in a God and a future state. The result of this is that infidels may be looked upon as outlaws, and, if the conviction of a robber depends on their testimony, he may go free. This rule admits the evidence of those atheists who deny their faith, and excludes those who are brave enough to openly affirm it. A citizen's safety, rights, and property may thus be made to depend upon his belief. What rational man would not willingly believe the testimony of Huxley, Spencer, or Ingersoll on questions involving rights between themselves and other men? Yet these, under our free government, might be challenged as witnesses on religious ground, and thus deprived of the protection of the state.

By the Constitution of the United States all citizens are to be protected against all unlawful searches and seizures; but these rights are continually violated, without redress, by the action of brutal and ignorant officers who, without authority, make police raids and do irreparable injury to innocent men.

Space will not permit of the further recital of offenses, but what has been said will show clearly that the state has done acts that are as deserving of the name of crime as anything committed by the citizen; and, further, that we have drifted into a passive condition of assent to the doctrine that "we, the people," can do no wrong. The effect on the community of the ills that have been set forth is demoralizing, and weakens the stability of the state as a body.

The principal question of human affairs must ever be the proper adjustment of the rights of the individual as against society. The value of existence to the citizen depends upon the restraints placed on the actions of other people. Yet looking at the subject in its widest sense, how little has been done! The influence of custom is so great that the rules laid down by the superior power appear self-justifying. The struggle between liberty and authority—the man and the tyrant—has given place to a more representative government; but success in politics, as in persons, sometimes brings with it infirmities, and popular control may perpetuate in other forms the wrongs of despots long gone.

The question is not new. In some form or other it has been before mankind from the remotest ages. The law that the king could do no wrong has been declared inapplicable to our republican government. But in the monarch's place appears the hydra-headed tyrant—the state. The authority of this body, more dangerous than the power of the king, presents itself under new conditions that require deep consideration and fundamental treatment.

The remedy for many of the troubles is extremely simple. Let the state be the subject of suit in all cases where it has injured its citizens by acts which would come within the cognizance of laws between individuals; let twelve men adjust the differences between the one who has suffered for the good of the many and the corporate body that represents the public. This is done in all cases where property is taken by corporations created by the state, and there is no reason to prevent the application of the same rules to the principal as is applied to the agents. The time has gone by for the invoking of ancient doctrines at the expense of the liberty and the justice due to the citizen.

Despite the fanciful theories of the new school of political economists, the strong force of personal impulses and preferences are the mainsprings from which the advancement of the world takes its movement. The protection of the freedom and rights of the individual against the power of the state is as important as that society shall be protected against him, and any system of laws or social science that ignores this fact is certain to retard the cause of progressive government.

GREETING BY GESTURE.

By GARRICK MALLERY.

II.

SALUTATIONS WITHOUT CONTACT.—The salutation now most prevalent among civilized people is the bow. That, in its abbreviated form, consists in a forward inclination of the head, sometimes accentuated by a corresponding motion of the arms, as in the *salam*, sometimes deepened by the depression of the upper part of the body. It is regarded by Herbert Spencer as merely a modification from the expressions of physical fear and bodily subjection noticed among subhuman animals and the lowest races of man. It originates, he says, with abject prostration and groveling, to which crawling and kneeling succeed, and the bow is but a simulated and partial prostration. An argument for this explanation is drawn from usages of savages and of antiquity.

A large class of obeisances undoubtedly had their origin in the attitudes of deprecation. A modern and familiar instance, also illustrative of the religious attitude of adoration and supplication, is in the "hands up" of our Western plains, which is an old Indian gesture sign for "no fight" or "surrender"—the palm of the empty hand being held toward the person to whom the surrender is made or implied. The Thlinkits, in addition to holding up their hands as a confession of utter helplessness, also turn their backs. The concept of peace is close to that of surrender, and the Indian sign described is often used simply for "friend." The members of the Wonkomarra tribe salute one another on meeting by throwing their hands up to their heads. The etiquette of the Todas is in point to show that prostration and groveling are voluntarily performed in ceremony. One party falls at the other's feet, crouching, and the other places first the right and next the left foot on the prostrate head. But all this is done with high good humor as being the correct etiquette, and by no means cruel in the one party or shameful to the other. In southern India the inferior prostrates himself with extended arms to show entire helplessness. In Japan the host and hostess fall on their knees and lower their faces to the floor, the nose and chin resting on the back of the right hand, to which the visitor responds in the same manner. Sometimes both parties distinctly and repeatedly strike the floor with their heads.

It must also be admitted that the principle of the superior preserving an easy posture and the inferior assuming one of physical inconvenience is obvious in many ceremonials. In the court of France the right of sitting in the presence of the monarch, though on a low, armless, and backless stool called a tabouret, was jealously guarded, the exceptions even in favor of age and sex being made by special edict; and, although prostration is Mr. Spencer's great original of all respectful forms, recumbency in the court mentioned was not to be imagined. A quaint illustration of this is in the device by which alone it was considered possible for Louis XIII to pay a necessary visit to Cardinal Richelieu when confined to his bed. The king had another bed prepared, and on his arrival at once lay down on it himself, so that his subject had at least no advantage over him. The same concept rules the customs of many lands. In Monbutto no servant is permitted to address his superior except in a stooping posture with his hands upon his knees. The Hindoo in the presence of a Brahman raises his folded hands to his forehead, touching it with the balls of his thumbs, uttering at the same time a word meaning "prostration," which clearly explains the gesture. But notwithstanding this array of examples in favor of the origin of the bow from physical fear, there is reason to believe it had a separate and independent course of evolution, and that the subject is much more complex than as hitherto presented.

Mr. Spencer's theory about the origin of the bow must refer exclusively to the actions of the inferior toward the superior, in the same manner that his theory of the derivation of the handshake, really hand-grasp, depends upon the conduct of equals.

Both motions, however, are interconnected, and the weight of testimony inclines against both of his explanations. Most of his views expressed in his chapters on Ceremonial Institutions are beyond controversy, but regarding some portions in the narrow field of the present discussion there is now more known, through scientifically conducted explorations, than when those chapters were written. It is now possible to approach the subject from a direction to which Darwin led the way in his volume on The Expression of the Emotions in Man and Animals, and from study of the sign-language as still extant among some bodies of men.

Among several tribes the chief must never see any head more elevated than his own, so that the sitting posture, though one of greater ease, is one of respect. This is mentioned by the French missionaries in 1611 regarding the Iroquois and northern Algonquins. Sitting and kneeling are more distinct in territory than in concept. The male foot-scrape and the female courtesy, recently common in Europe in connection with the bow, may be relics of kneeling or simply of pretended lowering of the stature. Japan was emphatically the "kneeling country." The very costume of the Tycoon's court required the silk trousers to form an angle at the heels so as to trail far behind, thus simulating kneeling even when walking. But the Japanese habitually did not sit except in a semi-kneeling crouch, so that kneeling was to them the normal mode of lowering the person. In some other countries it was also forbidden to stand erect in the ruler's presence, but sitting took the place of kneeling. In Java sitting down is a mark of respect; in the Mariana Islands the inferior squats to speak to a superior, who would consider himself degraded by sitting in the presence of one who should be objectively as well as figuratively "below" him. Similar rules of etiquette prevail in Rotouma. Some of the African kings ingeniously reconcile the relative elevation with their own comfort by sitting down themselves while their subjects squat, kneel, or crouch. Prof. Hovelacque explains the dismounting of Kirghiz horsemen, when they salute, on the principle of descending from an elevation through courtesy. It is, however, probable that such dismounting is required as a measure of precaution, on the same principle that a horseman approaching a military picket is required to dismount before giving the countersign. This is both to insure the countersign being spoken so low as not to be overheard, and also to render less feasible a sudden attack and dash through the lines.

The relative elevation is an example of what is taught by oral as well as sign language to express the concepts of superior and inferior, above and below, high and low. A Cheyenne sign for "chief" pantomimically shows "he who stands still and commands;" but the most common sign consists in raising the index-finger held upward, vertically to and above the head, the concept being "the one who is above others." The same sign has variants in many lands. Baker was greeted at Shoa by each native seizing both his hands and raising his arms three times to their full stretch above his head. Perhaps this was to make him give the sign of chief, which as in fact made by them through him implied, "you are our superior," "we submit to you."

The Andamanese salute by raising one leg and touching the lower part of the thigh with the hand. This gesture, which among some peoples is insulting, in the light afforded by sign-language may mean, "I am supposed to be sitting"—equal to the modern "your servant." With this expression may be compared the custom of the Zambesi, who, according to Livingstone, show respect by slapping their thighs, and gratitude for presents by holding them in one hand and with the other slapping their thighs.

The punctilios relating to the fundamental rule that rank is defined by elevation are carried to absurdity in the Orient. When an English carriage was procured for the Rajah of Lombok it was found impossible to use it because the driver's seat was the highest, and for the same reason successive kings of Ava refused to ride in the carriages presented to them by ambassadors. In Burmah, that a floor overhead should be occupied would be felt as a degradation, contrary to civilized ideas that the lower stories are the most honorable. In Siam, on the principle that no man can raise his head to the level of his superior, he must not cross a bridge if one of higher rank chances to be passing below, and no mean person may walk upon a floor above that occupied by his betters. On the same principle the furniture or stage setting for old ceremonies required the dais or raised platform for the seats of dignitaries. That elevation has become convenient for preserving order to officers presiding over assemblies, so that their seat has grown in prominence, while the royal or nobiliary dais has become exceptional or at least occasional.

From this executed concept of higher and lower the mere diminution of stature by bowing the head has possibly some relation. Explanation may be suggested by two salutations of the Chinese. Ceremonially they bend forward more or less deeply, with hands joined on the breast. Their less formal greeting is to raise the arms in front with the hands joined, thus forming an arch the elevation of which specifies the degree of respect. The Cossacks "bow to the girdle"—that is, bend forward so as to form a right angle at the waist.

In gesture-speech, the consensus throughout the world is that a forward inclination of the head, or in its place a similar motion of the hand in advance with an easy descent, as if in the curve of least resistance, signifies assent, approval, agreement.

It is the opposite of the transverse motion which shows negation, discordance, enmity, crossness. A lower inclination, either of head or hand, is emphatic, and often shows respect, not necessarily fear, as made to the older and wiser as also to the more powerful by rank or physical prowess. Forms of kindred expressions are still so common as to be classed as natural or involuntary. The head erect or thrown back with the eyes fixed to meet those of others shows haughtiness, defiance, or impudence. Casting down the eyes with an assisting inclination of the head is the evidence of modesty, yielding, gentleness, or subservience, according to the degree of action. Hanging the head may, however, exhibit dissent accompanied by shame. Le Page du Pratz gives an account of the gesture as observed by him among the Natchez at about 1718: "In the war-songs the great chief recites his exploits. Those who know them to be true respond with a long 'hou!' and certify their truth. Applause in the councils is also by the sound 'hou!' Their want of satisfaction is given by lowering the head and maintaining silence."

A more poetical and rather metaphorical variation sometimes occurs from the pretense of the unsupportable glory and brilliance of the dignitary approached, where the eyelids must be partially closed, a bow of the head assisting in their shading, and the hands sometimes advanced as an additional screen, in which motion the *salam* has a supposable origin. Curiously enough, this gesture, regarded as purely Oriental, was observed by Marquette on his visit to the Illinois in 1673, where "the Host stood before the Cabin, having both his Hands lifted up to Heaven, opposite to the Sun, insomuch that it darted its rays thro' his Fingers, upon his Face; and when we came near him, he told us, What a fair Day this is since thou comest to visit us!" Adair tells that the Southern tribes in the United States never bowed to one another, but did in their religious ceremonies, which perhaps was with reference to the effulgent rays of the sun, the object of their special adoration. Such instances tend to show that the origin of the bow was not always in the abjectness of physical fear.

Touching the ground in connection with salutation, though asserted to be derived from kneeling or prostration, does not necessarily arise from fear, or indicate any more than the relative higher and lower station. For instance, at Amorgos in the Cyclades the priest, on entering his father's house, touched the ground with his fingers, as a token of respect, before embracing him. His sisters touched the ground with their fingers before kissing the proffered hand of their brother. In each case there was expressed affection while the rank was recognized by the lowering reference to the ground. In the second dispatch of Cortes he describes his reception by the principal Mexicans, each of whom put his own hand to the ground and then kissed it. A yet clearer illustration is shown in the practice still existing in some parts of Germany, that the inferior calling upon a high official should knock at the door, whether open or closed, of the latter's apartments, not at the convenient level of his hand, but low down near the flooring, thereby humbly indicating his station. An actual lowering of the head is required in these cases, but normally it is not seen and is only incidental to the main action. A truly gallant sentiment appears in the custom in some Dutch cities of bowing when passing the house where a lady friend resides, even though it may be certain that the salute can not be seen. Her presence, real or supposed, receives the compliment.

In southeastern Africa, two chiefs, each claiming to be at least the other's equal, can never meet because the initiative in salutation acknowledges the superiority in rank of the chief saluted. If no salutation is made, the followers fall to blows and war begins. But among the Mbengas it is the duty of the highest in position to make the first salutation, a curious example of the coincidence between the low types of man and the latest culture which rules that a lady has the privilege as well as duty of recognition. Such salutes must always be returned, and indeed nearly all forms and expressions of greeting must be reciprocated as made, even among savages who are the representatives of antiquity, this fact militating against the degrading origin of the bow, which could only apply when made by one party—viz., the inferior. To adduce one instance among many: The king of the Hoorn Islands, early in the seventeenth century, receiving the party of discovery, held his hands against each other with his face above them for two hours, lowering himself nearly to the ground, and remaining so until the visitor had paid him the like reverence. Until then the ceremony was incomplete.

The uncovering of the masculine head, with or without the forward bow, by removal of whatever head-dress is upon it, is also explained by Mr. Spencer on the principle of fear. It means to him a removal of part of the clothing as symbolical of the whole, and thereby is an abbreviation of the exhibition or pretense of poverty, helplessness, and abjectness by which the wrath or greed of a tyrant is deprecated. In support of this view many usages are cited in which whole or partial nakedness and displayed misery seem to become ceremonial. It is also true that the respective costumes of the master and servants were often designed to assert that the former alone was big. Not only such titles as Highness, Celsitude, and Altitude implied elevation before mentioned, but those like Majesty and Magnitude demanded the show of relative size. Similar devices to distinguish the great appear in sign-language and picture-writing. In the ancient Egyptian pictures the king was always enormous and his surrounders were very small fellahs. The Mexican glyphs also signify great by big. Yet these devices do not conclusively show the effect of fear. They are but symbolic of high and low, big and little, as those figurative terms are applied to-day in English, and with corresponding significance in all languages, to discriminate between stations and ranks.

There are, however, instances directly opposed to the theory that uncovering is a mark of inferiority, and others are traceable to divers concepts. The Oriental custom of uncovering the feet, arising, as generally understood, in the imputation of holiness to a locality, has a curious parallel, if not an explanation, in the experience of Lewis and Clarke in 1805. The Western Indians, before the ceremonial smoke, "pulled off their moccasins, a custom which . . . imprecates on themselves the misery of going barefoot forever, if they are faithless to their words," on their thorny lands. A similar imprecation having regard to the burning sands in lands where the practice was first noticed might have induced it there. Should the religious ceremony in time be performed only at certain places or in buildings, the original significance would be lost and the locality itself simply considered holy. It is perhaps not fair to adduce historical cases in which the inferiors were expected to don their most sumptuous raiment to do honor to the king or general, while the latter, perhaps in affectation, was clad more soberly than any of his retinue. But there are many savage and ancient examples in which, instead of uncovering being the form for respect, envelopment, or indeed muffling, was adopted. Though generally in the Orient respect requires the feet to be bared, the head must be covered. The Israelite practice is familiar, and many other peoples, e. g., the Malabarese and the Malays, preserve covering on their heads in their temples and pagodas to show reverence. Although the New-Irelanders in respect take off the usual head-gear, they place their hands on their heads as a more honorable covering. Quakers, in avoiding the usual Christian ceremony of uncovering on taking an affirmation and on other religious occasions, use a pagan ceremony by insisting on keeping on their hats.

The Thibetans when before the *dolai-lama* remove their hats, cross their arms over the breast, and stick out the tongue drawn to a point. A collation of the known cases of the curious salute by the pointed tongue leads to the suggestion that it is connected with the conception before mentioned that the subject is too great to admit of speech. The extended tongue prevents speech as completely and even more obviously than does the covering of the mouth by the hand. It is, however, possible that the gesture symbolically signifies reaching out for a good taste, which also has been discussed. This gesture is common among the Australians, who are said to stick out the tongue in respect, not in derision, as we would regard the action, as also did Isaiah in his query, "Against whom make you a wide mouth and draw out the tongue?" But close observers report that the Australian tribes wholly unaffected by Europeans do not thrust forward the tongue, but extend it downward from the widely opened mouth as in the preparation for licking. The action of these people, perhaps the lowest of all humanity, is similar to the tasting and sniffing by the subhuman animals to distinguish friends.

Cyrus beheaded two satraps because they omitted to place their hands inside their sleeves when they saluted him. Captain Speke had trouble in Uganda lest he should not be admitted into the king's presence wearing his usual dress, without the concealment of his trousers by flowing robes. Probably the origin of these rules of etiquette was the restriction from free motion of the arms and legs of the subjects, so as to insure greater safety to the ruler. In the one hundred and seventieth of the Arabian Nights' Entertainments Prince Camaralzaman showed respect for his father by keeping his hands joined behind his back and covered by his sleeves, but when he became angry with the king he unclasped his hands from behind and rolled his sleeves up on his arms. This is the fighting attitude, and shows that the posture and muffling of respect were adopted because they were the converse of the free pose appropriate for contention. With the same concept a Sahaptin chief, in the early part of this century, threw his robe down on the ground as a sign of displeasure, though not intending an attack.

Other considerations may be mentioned in the direct line of militancy so often discussed in the Synthetic Philosophy, but not definitely in this connection. Apart from the purely ornamental head-gear, such as feathers, horse-hair, fur, and other attachments, the earliest coverings for the head were for defensive purposes. The abandonment of defensive as well as of offensive armor, though once a mark of defeat and subjection, is now more generally a sign of peace and friendship. Some African tribes not only ostentatiously lay down all weapons but remove the upper portion of their clothing to show that neither arms nor armor are concealed. Some formal military salutes still prevailing may be consulted upon the same topic. The theory of these is to render the saluter actually or symbolically powerless for the time. This is the case with the firing of unshotted guns, the dropping of the sword-point, and presenting the musket. The common military salute, in which the empty hand, with palm outward, is raised to the visor, is less objective and more symbolical. Similarly, the special naval salute by lowering sails and manning yards places the vessel in a position of inaction. In the same manner the removal of his helmet left the ancient warrior defenseless in the most vulnerable, often the only protected, part of his person. This action, therefore, would present a better argument for the surrender than for the beggary theory, and it is strengthened by the fact that women, who did not wear helmets, have not generally been required to remove their head-gear in public. It is also to be noticed, in reference to the interconnection of ceremonials, that the motion of removing the hat is normally downward, thus including the concept of assuming an inferior height before discussed. The crest, which often showed the warrior's cognizance, as the flag shows that of nations, was lowered, as the flag is, in formal respect. A pretended or symbolized uncovering and lowering appears when the English and French *prolétaires* and peasants pull a lock of their hair in servile obeisance to their superiors.

The special privilege in old Spain of wearing the hat in the presence of the sovereign may be compared with the limitation of sitting in the French court, before mentioned. Spanish grandees were distinguished by the cherished prerogative of wearing their hats before their king when his hat was on, though not when he was uncovered. Mr. H. Ling Roth, in his excellent paper On Salutations, falls into a small error on this subject. It was not, in the time of the Tudors, "the custom in England, when a gentleman lost his bonnet, for all those who were with him to doff theirs," nor was it simply the omission of that act as one of ordinary politeness which indicated the coming fall of Thomas Cromwell. That the courtiers should retain their hats while he was uncovered, was much more distinctly than mere rudeness the assertion that they did not consider him to be their ruler. All ambassadors have the privilege, though now seldom used, of putting on their hats when they read their reception speeches, the sovereign principal being then more specially represented than on any other occasion. When the Cossacks met for counsel, not being then an army but a brotherhood, they kept on their hats, but their *ataman*, when addressing them and explaining his cause, removed his head-covering. When he asserted command as the head of the army he donned his hat, and the same members of the council, before covered, removed theirs.

In most parts of the civilized world the hat, in ordinary greeting, is now seldom wholly removed from the head, and the latter is but slightly inclined. The action is much abbreviated, and doffing is simulated by a touch of the brim, or by a great variety of jerks or waves of the hand and arm to which the head-covering is the *point d'appui*. These motions are full of interest to the gesture-reader. They generally suppose some degree of real or perfunctory respect, but may indicate pride as well as humility, familiar affection or cold formality, welcome or aversion, even irony or derision. The Poles and Cossacks use the phrase, "With the forehead to you," when, in fact, there is no bow made. This is on the same principle as the phrase, "I kiss your hands," when the hands are not kissed. Both expressions are relics of actions, and neither means more than the English "my respects." Likewise, through the Russian Empire, "I fall at your feet," is often said to men, and "I kiss your feet" to women, though those performances do not take place.

The above considerations lead to the conclusion that several known motions expressive of emotions, both separately and together, tend to explain the bow. Furthermore, these motions, and the emotions or concepts expressed by them, seem to be as ancient as any known to have been common among men. It will, therefore, appear that the genesis of our bow does not appear exclusively and among all peoples in the groveling of the whipped hound or the cowering of the dastard slave. Perhaps on examining all the tribes of men a theory that prostration was but an exaggerated bow might be as well maintained as one that the bow is a relic and symbol of prostration, but it is now only suggested that the two expressions may be independent.

Clapping Hands.—At this point an attempt may be made to explain the curious custom of clapping the hands in salutation.

Among the Uvinza, "when two 'grandees' meet, the junior leans forward, bends his knees, and places the palms of his hands on the ground on each side of his feet, while the senior claps his own hands six or seven times. They then change round, and the junior slaps himself first under the left armpit, and then under the right. But, when a 'swell' meets an inferior, the superior only claps his hands, and does not fully return the salutation by following the motions of the one who first salutes. On two commoners meeting, they pat their stomachs, then clap hands at each other, and finally shake" (i. e., take) "hands. These greetings are observed to an unlimited extent, and the sound of patting and clapping is almost unceasing." Serpa Pinto found this ceremonial clapping in violent exercise among the Ambuellas. Paul du Chaillu reports the salute of the Ishogos to be clapping the hands together and stretching them out alternately several times. Among the Walunga, in the morning, on every side a continuous clapping of hands goes on, with the accompaniment of "*Kwi-tata, kwi-tata?*" which is their mode of saying, "How d'ye do?" If a chief passes, they drop on their knees, bow their heads to the ground, clap vigorously, and humbly mutter, "*Kwi-tata, kwi-*

tata?" The clapping distinguishes the ceremony from that of mere prostration.

When the people of Londa wish to be excessively polite they bring a quantity of ashes or clay in a piece of skin, and, taking up handfuls, rub it on the chest and upper front part of each arm; others in saluting drum their ribs with their elbows; while still others touch the ground with one cheek after the other, and clap their hands. The chiefs go through the semblance of rubbing the sand on the arms, but only make a feint of picking it up. Among the Warna, an inferior in saluting a superior takes a piece of dried mud in his right hand; he first rubs his own left arm above the elbow and his left side, then, throwing the mud into his left hand, he in like manner rubs the right arm and side, all the time muttering away inquiries about his friend's health. Each time the chief's name is mentioned every one begins rubbing his breast with mud.

From these notes the elements of the clapping pantomime may be resolved into, first, beating or slapping the arms and upper parts of the breast, sometimes rubbing them with mud—these being ancient modes of expressing grief—and afterward the noise of the slaps is simulated by clapping the hands. It is well known that many peoples act both in pantomime and with speeches to disguise their happiness and thereby escape the notice of malevolent demons. It is also known that among certain tribes, on the meeting of friends who have been long absent, markedly when they have been in danger, the welcoming party gash their arms and breasts so as to draw blood, which placates the jealous gods on the joyous occasion. When the actions become simulated and symbolic, the claps in the examples cited may represent the wounding strokes, and the mud-stains imitate those of blood. When the superstition has decayed, such actions, and afterward their simulation, may be used as any happy greetings.

It is not forgotten, however, that clapping hands is used for applause and rejoicing, as in Ezekiel, xxv, 6: "Because thou hast clapped thine hands, and stamped with the feet, and rejoiced in heart." But "clap at" is used with hiss in Job, xxvii, 23, and also in Lamentations, ii, 15, to signify derision. In this respect the gesture shows the general nature of gesture-signs which, according to the manner of use and the context, can be applied with many shades of significance—indeed, by very slight changes can express opposite meanings. It is at least as flexible as oral speech, which gains the same result by collocations of words and modulations of voice.

Joy-weeping.—One of the most curious of the demonstrations upon the meeting of friends is that called "joy-weeping," which also may be connected with the dread of jealous demons. Crying, both with tears and with howls at such times of gladness, is known in many lands. It has been lately reported among the Andamanese and was noticed by Cabeza de Vaca in 1527 among the Caddoes of Texas and Louisiana. It may also be construed as mentioned about the ancient Israelites in the twenty-ninth, thirty-third, and forty-fifth chapters of Genesis, where weeping is recorded at the meeting of Jacob and Rachel, Jacob and Esau, and Joseph and Benjamin. Singularly enough, the same practice was found existing fifty years ago in central Australia, where parents upon meeting children after a long absence fell upon their necks and wept bitterly. The Tahitians cut themselves with shark's teeth and indulge in loud wailing to testify gladness at the arrival of a friend, and the New-Zealanders scarify themselves with lava on such meetings.

Dr. E. B. Tylor explains the practice as mourning for those who had died during the interval of separation, thus following Hennepin in his account of La Salle's visit to the Biskatronge nation in 1685 as follows: "At their arrival those people fell a-crying most bitterly for a quarter of an hour. This is their custom whenever there comes any strangers afar off amongst them, because their arrival puts them in mind of their deceased relations which they imagine to be upon a great journey, and whose return they expect every hour." The proceeding is explained in the account by Alexander Henry of the Assiniboin feasts in 1776 which were begun by the violent weeping of the whole party, and the reason they gave was that it was in memory of their deceased relatives whose absence was brought fresh into their minds. This religious ceremonial of the Indians was mistaken by some travelers for salutation, which it only resembled as the formal grace before meat resembles the modern "good-morning" or the libation among the Romans was analogous to the "*salve*" of their daily life.

Hennepin's explanation does not apply to the large majority of the cases known, and indeed is properly grief-weeping. If joy-weeping is not to be classed with the tricks to deceive the jealous gods, it possibly arises from the familiar agitation in which the signs of extreme joy and mirth are similar to those of grief. Most of us have laughed until tears rolled down our cheeks. Such exhibitions may have induced the real or imitative expression of joy by crying. In this connection it is curious that the English word "greeting," defined as a kind salutation, is still preserved in the lowland Scotch dialect with the sense of weeping or mourning.

The Heart.—Gestures of salutation, the motions of which are directly connected with the heart, have some special interest.

In some Oriental countries the mere bow was not held to be enough. Sometimes the right hand was placed across the head.

Sometimes the hand was put first to the forehead and then to the heart—perhaps to symbolize that intellect and love are at the disposal of the one addressed. In this simple form, but as an invocation, the sign has been translated as "may my head be the penalty if my heart be false!" A similar gesture, imitating with the hand the act of cutting the throat, and sometimes before and sometimes afterward touching the heart, is represented as having the same significance, "On my head be it!"

In Greece the ancient style of greeting a priest is still observed by placing the hand on the breast and inclining forward; and the Lander party in the Niger basin were obliged to bend forward and to place their hands with solemnity on their heads and breasts. Tribes of Eskimos in 1833 saluted by patting their breasts and pointing to the heavens. In the same year a Kansas warrior grasped hands with the party greeted and then pressed his own bare breast. In 1886 tribes of eastern equatorial Africa, with the same intent of friendship, grasped hands and rapped their own breasts. All these gestures meant that the heart was "good," perhaps poetically then it beat in sympathy. The Fuegians, as a greeting of friendship, pat their own breasts, concluding by three hand-slaps given at the same time on the breast and back of the friend, then bare their own bosoms for a return of the slaps. A Texan tribe, in 1685, expressed friendship by laying their hands on their hearts, and evidently expected La Salle's party to respond in the same manner, which was done. A Ha-va-su-paí, of Arizona, grasps the hand of a friend on meeting, moving the hand up and down in time to the words of his greeting; and, as he lets it go, lifts his own hollow palm toward his mouth, then, with a sudden and graceful motion, passes it down over his heart. Here, in addition to the concluding emphasis connected with the heart, there is a motion which might be mistaken for hand-kissing, and also the nearest approach to "shaking" the hand among savages or barbarians which has been accurately reported. But to beat the time of a rhythmic formula is very different from the English pump-handle shake, even when it was less hideous than the last "fad" with the raised elbow, and its intent is the very opposite of Mr. Spencer's struggle.

Two of the special signs for "good" in the sign-language of the Indians may be mentioned as in point. Hold the extended right hand, back up, in front of and close to the left breast, fingers extended, touching, and pointing to left (index-finger usually rests against the breast in this position); move the hand briskly, well out to front and right, keeping it in the same horizontal plane. Concept, "Level with the heart." Or pass the opened right hand, palm downward, through an arc of about ninety degrees from the heart, about two feet horizontally forward and to the right. "Heart easy or smooth." "My bosom's lord sits lightly on its throne."

The kalmucks salute their high chiefs by pressing the forehead with the clinched hand, and then touching the chief's side with the same hand. The chief responds by placing one of his hands on the saluter's shoulders. This may be translated as "My head is dependent on the emotion of your heart"; and the response is, "I accept your offering, and recognize that I possess you."

Intimately connected with the imagery of the heart is the union by exchange of blood. In ancient Persia, as in modern Africa, it was common to open a vein and then present the blood to be drunk by the friend. This was and is often mutual. Perhaps it is straining the illustration to infer that when the Wanika, after the hand-grasp, press together the balls of their respective thumbs, it is to effect the union of the pulsations. It is, however, in point that the Norse pledge of friendship was to allow the blood to flow between the pierced and grasped hands, and it has been conjectured that "striking hands," often alluded to in the Old Testament (e. g., Proverbs, vi, 1) as a ceremony of covenant, meant an actual intermingling of blood from the pierced palms, or at least was a relic and symbol of that form. But it is fanciful to explain the simple hand-grasp from this blood-mixing; indeed, all symbolism should be closely scrutinized. Stanley reports that the natives of Panga, as a peace greeting—being at a distance from the party greeted—poured water on their own heads and sprinkled their bodies with it. Much of the symbolism about the solvent and cleansing qualities of water, including origins of lustration and baptism, might be deduced from this performance, but it was simply the sign of coolness and refreshment elsewhere mentioned in these pages.

Miscellaneous Salutes.—It is impossible, within present limits, to detail the world's many forms of gestural salutation. They, like all gesture-signs, show different conceptions of the same general intent and different modes of expressing the same concept. They are also in many cases so abbreviated and modulated as to be intelligible in their present forms only through comparison and investigation. A few salutes having special interest may be mentioned.

The important mystic agency of saliva has before been noticed in connection with the hand-grasp. It is too large a topic to be now dwelt upon; but some examples may be given of its immediate connection with salutation. Among the Masai, spitting expresses the greatest good-will and the best of wishes. It takes the place of the compliments of the season. They spit when they meet, and do the same on parting. In some of the South Sea islands they spit on the hands and then rub the face of the complimented person. Schweinfurth says of the Dyoor that mutual spitting betokened the most affectionate good-will.

The inhabitants of Hainan gracefully greet a guest by extending the arms, the hands open with the finger-tips touching, or nearly so, and drawing them inward with an inviting motion. They bid farewell by extending the open hands with the palms upward and slightly inclined outward, in a movement as if handing the friend on his way. In arctic America there is a queer example of returning a kiss for a blow. A stranger coming to the village is regaled with chant and dance, after which he folds his arms, and the head Ancoot hits him as hard as he can on the cheek, often knocking him down. The actors then change parts, and the visitor knocks him in the same way, after which they kiss (probably on the cheek, but not described), and the ceremony is over.

In this connection the supposed hand-kissing struggle to explain the hand-grasp may again be mentioned with an additional criticism. The hand-grasp was common among those peoples of the world who now use it in greeting before altruism had made so much progress as to reverse many of the old conventions of precedence.

After examination of the whole subject there appears to be significance in the connection before suggested between the offering of the unarmed hand and the strictly military salute with sword, rifle, and cannon. They all display temporary defenselessness, though not now through fear, but the reverse—trust and confidence—and they are always returned with rivalry only in the demonstration of amity. This is but one instance to prove that militancy is not a mere incarnation of evil and drag upon civilization. Spencer accuses it of paralyzing humanity through fear, of originating deception and lies, and of antagonism to justice and mercy. But militancy has shown a most interesting and instructive evolution within itself. Modern armies, by the education and discipline enforced, furnish to the world perhaps as large a number of really valuable men as they cost.

It will be noticed that in proportion to advance in civilization and culture, gestural salutations—as is also true of the verbal—are exchanged or returned, thus denoting a mutual sentiment or sympathy. A gesture of greeting is now seldom made exclusively by one class to be merely received by another, but meets with reciprocity, though often in abbreviation. It is not contended that the most degrading theory of the origin of some of the gestures treated of may not be correctly applied to some tribes and regions, though it is suggested, from the information given by sign-language and from many compared facts, that among other peoples those gestures originated in different and independent concepts. But if cowardice and slavishness gave the true and only explanation, still more pointed would be the lesson taught by the modern general exchange of the same courteous action between strong and weak, rich and poor.

The history of salutations does not directly show the contest of good and evil or of any principles, but it illustrates the transition from egoism to altruism. Whatever was a custom, men considered to be right, while it lasted. Men have not at any time chosen between industrialism and militarism, but an evolution has proceeded in industrialism and militarism themselves as also in peoples, who have advanced, though slowly and with stumbles, from lower to higher planes of culture. Differing environments affected their earliest conceptions and practices, and expedited or delayed their march. Those peoples who have reached civilization and enlightenment can still find the representatives of their early greetings among remote savages, and perhaps trace some of the salutations above mentioned to subhuman ancestors. Ages before the great poet wrote, the human race obeyed the precept, to

> "Move upward, working out the beast,
> And let the ape and tiger die."

Note.—A similar study of verbal salutations, inculcating the same lessons as the present article on gestural greetings, has been published by the same author in the American Anthropologist for July, 1890, under the title of Customs of Courtesy.

[*Concluded.*]

NON-CONDUCTORS OF HEAT.

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IT is a matter of common observation that a hot body continually gives off its heat to things around it, until at length the giver and the receivers all come to a common temperature. This gradual equalization may be brought about in three different ways: In the first place, heat is thrown off in every possible direction from every point of a heated body by what we call radiation. Secondly, when air, water, or any other fluid is in contact with a hot surface that is not directly over it, the touching particles become warm and light, and move away to give place to others. This carrying away heat by the successive particles of a fluid is called convection. In the third place, when a solid substance is placed against anything of a higher temperature, its nearest parts are warmed and give up a portion of the heat received to those parts lying next to them; and these, again, share their gain with those next in order; and so on, till finally the outer surface heats whatever is in contact with it. Such conveyance of heat from particle to particle, without sensible motion, is termed conduction.

Strictly speaking, according to modern theory, radiant heat is a peculiar kind of undulation communicated to a supposed exceedingly subtile, all-pervading ether; and conduction is an oscillation of the molecules of the conductor itself. But, though we no longer consider heat to be a substance, it is convenient to use the old terms figuratively in describing the phenomena, just as we still say the sun rises and sets, though it is the earth that moves.

When we sit near an open fire, we are warmed by radiation through the intervening air, while the air itself is heated by contact with the fire and passes up the chimney. So radiation and convection, or radiation and conduction, may go on at the same time, and when cooling takes place it is not always easy to tell how much of the effect is due to each of the causes respectively. Hence, substances that are put around hot bodies to retard the change of temperature are often called indiscriminately non-conductors, though in fact they may act partly by preventing convection or by intercepting radiation. Practically, indeed, it is of little consequence to decide exactly how the loss of heat is prevented, but, in the full study of retentive coverings, we must not altogether lose sight of the distinction between mere conduction and general transmission.

It is a matter of much interest as well as of economical importance to find out what substances are most suitable to keep hot bodies warm and cold bodies cool; and several methods have been devised for making either absolute or comparative trials. After due consideration of the plans used by different experimenters, the writer has adopted, for the many determinations which he has had occasion to make, an apparatus which may be arranged in three different ways: First, a short, cylindrical metallic vessel, with the flat ends vertical, is kept at a constant high temperature by a continual current of steam or hot water passing in at the bottom and out at the top. The non-conductor, of a regular thickness, say one inch, is applied to one of the flat faces of the heater. The other surface of the covering is in contact with a thin brass box, or calorimeter, filled with a known quantity of water to receive the transmitted heat. The number of degrees which the water is raised in an hour gives a definite measure of the amount of heat that the covering allows to pass through.

Secondly, in trying liquids or air for their conducting power it is desirable to get rid of convection by heating from above, so that the hottest part of the fluid shall be and remain at top.

Therefore the heater is suspended with its used face downward and exactly horizontal. The calorimeter, with its face also horizontal, is placed at any chosen distance below the heater, and is furnished with a curb of well-varnished pasteboard extending up a little higher than the face of the heater. This curb is of a somewhat larger diameter than the hot box, so that there is a free space all around, and very little heat can be conducted by it.

Thirdly, in making practical tests of coverings for steam-pipes the non-conductor is put entirely around the pipe and the calorimeter is made in two parts with concave sides to fit the covering. Of course, in all cases the whole apparatus is surrounded by cotton-wool or woolen blankets to prevent the disturbing influence of the surrounding air.

With the first arrangement, if the space between the calorimeter and the heater is filled with air only, which is confined by a curb of paper, but is free to circulate within the inclosure, the heat passes over rapidly, especially when the heater is at a very high temperature, while in the second apparatus the transmission is slow. In the former case, convection has full scope; in the latter, the air is stagnant and the heat passes downward by conduction and radiation. Therefore, still air has very little transmitting power, and confined air which is free to move around within the inclosure conveys heat readily.

Yet it is a not uncommon belief that, as air is a poor conductor of heat, a mere inclosed air-space around a hot or a very cold body suffices to prevent change of temperature. It is said by some that an ice-pitcher or a refrigerator needs only a double wall and no filling between. And we occasionally meet with loose statements like the following: "Confined air has long been regarded by scientific and practical men as one of the best non-conductors of heat." But it should be remembered that imprisonment is not always close confinement. The air must be fettered so that it can not stir.

Now, if we fill the space in either the first or the second apparatus with cotton or fine wool, we shall find the transmission even less than with still air. And yet the fibrous matter may actually occupy only a hundredth part of the space which it apparently fills, and the fibers can touch the heated surface and each other only in a few points. Therefore the specific conducting power of wool or cotton can have very little to do with their capability of keeping back heat. We know not precisely what the conducting power of the solid matter of cotton may be, for we can not compress the fibers far enough to destroy their elasticity and expel all the included air. But the woods are very similar in substance, and some of them are two thirds as dense as fully compacted cotton would be. One of the dry, hard woods, heavy enough to sink in water, was found to have about four times the transmitting power of loose cotton. Were the transmission due to the substance of the fibers themselves, it would be increased by packing more in the same space. But, in fact, it is found that it is somewhat diminished by moderate crowding.

It would appear, then, that the efficiency of light non-conductors must be owing mostly to the imprisoned air which really occupies all but a small fraction of the space; and the stiller the air is held, the better is the effect.

Of course, the amount of friction which fibers can oppose to the motion of the entrapped fluid depends on their minute structure and arrangement. Thus in cotton they are long, flat, twisted, irregular in breadth, and variously bent. And as to fineness, it was found by counting and weighing some Sea Island cotton fibers averaging about an inch and a half in length, that it would take seventeen thousand to weigh a grain. Wool is scaly and very crinkly. Down is made up of flat threads with innumerable short, loose branches. The heads of the common cat-tail (*Typha latifolia*), which make a good non-conductor, consist of brown seeds, each having a stalk with very spreading branches. The seeds, with their appendages, are so very fine that eight hundred of them weigh only one grain. They may well float, as each one, for its weight, presents a very extensive surface to the air; and, for the same reason, in mass they serve to keep the air stagnant.

Ground cork and some other barks, and the sawdust of the soft woods, as well as the charcoal made of these substances, are very good retainers of heat. Lampblack also works well. When the thing to be kept hot is at a very high temperature, some light, incombustible powders are very suitable. Among the best of these are fossil meal and the calcined magnesia and magnesium carbonate of the druggists. Fossil meal consists of the silicious skeletons of microscopic vegetables, called diatoms, exceedingly various in shape and size, the very largest of them hardly reaching the length of the hundredth of an inch. It is found abundantly in some peat meadows and in the bottoms of ponds. Both fossil meal and magnesium carbonate have been largely used in covering steam-pipes.

Obviously, when the same light substance is tried in both the first and second apparatus above mentioned, and the results differ, it must be owing to the inability of the substance to hold the included air still in the first arrangement. So powdered plumbago, or black lead, which is very slippery, shows nearly twice as much transmissive power in one case as in the other. Loosened asbestus fiber also lets through about twice as much heat in the vertical arrangement as in the horizontal. Yet this fiber may be split up exceedingly fine; but the great difference in its behavior as compared with cotton or wool must be owing much less to its own greater specific conducting power than to the smoothness and inelasticity of its fibers. It has too slight a hold on the included air. The more finely shredded it is the better it works; but our experiments have proved that it is not to be recommended as a non-conductor. And yet asbestus is often spoken of as though its excellence in this respect were unquestionable; but, because this wonderful mineral is very useful in many ways by reason of its incombustibility, it does not follow that it has any magic virtue in its other relations to heat. Asbestus paper intercepts heat somewhat better than the loose fiber; but a great many layers must be put together, and then the virtue is by no means commensurate with the cost. It is sometimes recommended as a suitable article to put between floors to prevent the spreading of a possible fire; but those who propose it for this use seem to overlook the fact that the efficiency of non-conductors is nearly proportional to their thickness, and, though an inch might be of some service, one fiftieth of an inch can do very little good.

Fibrous matters and powders in the loose state are somewhat troublesome to confine in the form of coverings, and hence they are sometimes consolidated into sheets or blocks which can be handled without breaking and applied easily. Hair-felt, which is made in thick sheets from the hair which tanners scrape from hides, is cheap and is very serviceable when the heat is not scorching. Paper pulp has been formed into very thick, hollow, half cylinders to put around steam-pipes. Carbonate of magnesium and fossil meal cohere when moistened and slightly compressed, and they may be made into slabs with the addition of a very small percentage of hair or asbestus to give toughness. Such a paste may be plastered directly on steam pipes or boilers and allowed to dry, the fiber serving to prevent cracking; but the greater compactness of light materials so consolidated renders them less effective, especially when a heavy cementing substance is added, like clay or plaster of Paris.

Of non-conducting substances that are already in the solid form, the light woods are often used advantageously. It should be noticed that most of them conduct heat much better along the grain than across it. Thus a cross-section of *Liriodendron,* or yellow poplar, was found to transmit heat nearly twice as fast as a board of the same thickness sawed lengthwise. Cork is expensive and hard to get in large pieces; but it is far preferable to wood, as it is lighter and more elastic and does not absorb water. Very porous and light bricks confine heat much better than those that are hard burned, but they must be kept dry.

The presence of moisture in a non-conductor greatly impairs its usefulness, as every one knows who has attempted to hold a hot body with a damp cloth. Count Rumford, who long ago did much valuable work in the experimental study of heat, concluded that fluids have no conducting power at all, but transmit heat solely by convection; and, accordingly, water is still sometimes spoken of as an exceedingly poor conductor. But later investigators have disproved the correctness of that idea. Our own trials show that, when convection is obviated, water transmits in a given time six times as much heat as hair-felt of the same thickness, and nearly eight times as much as still air. Others have found that bisulphide of carbon and ether transmit heat even better than water; but most liquid substances are slower conductors. Thus it takes more than twice as long for a given amount of heat to pass through cotton-seed oil or lard oil as through water.

As to the gases, some physicists seem to have proved that heat passes through air more readily than through a vacuum, while hydrogen has six times as much transmissive power, and carbonic acid half as much as air; but none of them used apparatus that would give absolutely certain results.

To show more clearly the retentive power of various substances, we subjoin the following table, in which the first column of figures shows the net percentage of solid matter in a given space. The second column of figures gives the number of English units of heat transmitted in one hour through one square foot of the covering one inch thick, the average difference of temperature between the heater and the water in the calorimeter being 100° Fahr. By the English unit of heat is meant as much heat as will raise the temperature of one pound of water 1° Fahr. Of course, the smaller the number in the last column the better is the substance for keeping a body warm or cold.

In some of the experiments the source of heat was steam at 310° Fahr. In the others a stream of water at about 176° Fahr. was kept running through the heater.

It is plain that in choosing non-conductors for practical service we should take into account something more than their heat-retaining power. They should be of materials that are abundant and cheap; clean and inodorous; light and easy of application; not liable to become compacted by jarring, or to change by long keeping; not attractive to insects or mice; not likely to scorch, char, or ignite at the long-continued highest temperature to which they may be exposed; not liable to spontaneous combustion when partly soaked with oil; not prone to attract moisture from the air; and not capable of exerting any chemical action on surfaces with which they are placed in contact. There is no one thing which combines all the desirable good qualities, but there is a considerable range of substances which fulfill most of the require-

NON-CONDUCTORS ONE INCH THICK.	Net cub. in. of solid matter in 100.	Heat units transmitted per sq. ft. per hour.
Still air	....	43
Confined air	....	108
" " = 310°	....	203
Wool = 310°	4·3	36
Absorbent cotton	2·8	36
Raw cotton	2	44
" "	1	48
Live-geese feathers = 310°	5	41
" " "	2	50
Cat-tail seeds and hairs	2·1	50
Scoured hair, not felted	9·6	52
Hair-felt	8·5	56
Lampblack = 310°	5·6	41
Cork, ground	....	45
Cork, solid	....	49
Cork charcoal = 310°	5·3	50
White-pine charcoal = 310°	11·9	58
Rice-chaff	14·6	78
Cypress (*Taxodium*) shavings	7	60
" " sawdust	20·1	84
" " board	31·3	83
" " cross-section	31·8	145
Yellow poplar (*Liriodendron*) sawdust	16·2	75
" " " board	36·4	76
" " " cross-section	30·4	141
"Tunera" wood, board	79·4	156
Slag wool, best	5·7	50
Carbonate of magnesium	6	50
Calcined magnesia = 310°	2·3	52
"Magnesia covering," light	8·5	58
" " heavy	13 6	73
Fossil meal = 310°	6	60
Zinc white = 310°	8·8	72
Ground chalk = 310°	25·3	80
Asbestus in still air	3	56
" in movable air	3·6	99
" " " = 310°	8·1	210
Dry plaster of Paris = 310°	36·8	131
Plumbago in still air	30·6	134
" in movable air = 310°	26·1	296
Coarse sand = 310°	52·9	264
Water, still	....	335
Starch jelly, very firm, "	....	345
Gum-arabic mucilage, "	....	290
Solution sugar, 70 per cent, "	....	251
Glycerin, "	....	197
Castor oil, "	....	136
Cotton-seed oil, "	....	129
Lard oil, "	....	125
Aniline, "	....	122
Mineral sperm oil, "	....	115
Oil of turpentine, "	....	95

ments. For steam-pipes there have been many more or less suitable coverings in the market. But one should receive with much allowance the representations of dealers, who sometimes continue to advertise what has been proved to be of inferior value. Not uncommonly they are anxious to sell that on which they can make the most profit rather than that which is most efficient.

ON VÕDU-WORSHIP.

By Hon. Major A. B. ELLIS.

SIR SPENCER ST. JOHN'S book Hayti, or the Black Republic, brought prominently before the English-speaking peoples of the Old and New Worlds the subject of the so-called vaudoux or voodoo worship which prevails in the island of Hayti-Santo Domingo; and the numerous articles published from time to time by Mr. G. W. Cable in Harper's and the Century Magazines have shown us what the "voodoo-worship" in Louisiana is like; but, as neither of these two authors has, apparently, had any personal acquaintance with that part of the west coast of Africa from which võdu is derived, they have, very naturally, been unable to more than describe it as they found it on this side of the Atlantic. They have been unable to tell us to what language the word *võdu* belongs, what it means, and what the various practices which in Hayti and Louisiana are roughly grouped together under the designation of vaudoux-worship really are. I fancy I can recollect an article, but by whom written I can not remember, in which the writer derived the word *vaudoux* from *Pays de Vaud;* and, as some light seems to be required on the subject, it is here proposed, though now perhaps rather late in the day, to give it.

The word võdu * belongs to the Ewe language, which is spoken on the Slave Coast of West Africa, between the river Volta on the west and the kingdom of Porto Novo on the east, and extends inland, as far as is yet known, about one hundred miles. It is derived from the verb *võ*—to inspire fear—and is used in just the same way as English-speaking people use the word "fetich"—that is to say, it is used as a descriptive noun "god," and also as an adjective in the sense of sacred or belonging to a god. Thus any native god may be described as *a* võdu, and his image, paraphernalia, and sacred tract of bush called võdu. A priest is termed võdu-no—"He who stays with the võdu." The word is not an epithet of any particular god, it is a general term; and it is, therefore, incorrect to say that "it is the name of an imaginary being of vast supernatural powers residing in the form of a harmless snake." No doubt the python-god, worshiped by the inhabitants of the southeastern districts of Ewe territory, may very correctly be described as a võdu; but it is not more a võdu than Khebioso, So, Legba, Bo, Hunti, Wu, and the other gods of the Ewe pantheon. The expression "võdu-worship" means, then, "god-worship," which is a rather comprehensive term.

* The Greek circumflex here indicates a highly nasal intonation. The *u*, as in all West African languages, is pronounced like *oo* in English.

Võdu worship, in so far as it relates to the worship of a snake, was undoubtedly introduced into Hayti by slaves from Whydah and Ardra, or Allada. Moreau de St. Méry, an old author who described Hayti while it was still a French colony, and who is quoted by Sir S. St. John and Mr. Cable, distinctly says it was introduced by the "Aradas"; and it is only in the neighborhood of those two old kingdoms that python-worship is to be found on the Slave Coast at the present day. Whydah and Ardra were, at the beginning of the eighteenth century, two small states situated near the southeastern corner of Ewe territory. Whydah, which had a sea front of some thirty miles, extended inland about seven miles, its northern boundary being a lagoon which ran east and west just beyond the town of Savi, called Xavier by old writers. Ardra, or Allada, lay inland of Whydah, and extended as far northward as the marshy belt called the *Ko*—that is, to about thirty-five miles in a straight line from the sea. Its capital, Ardra or Allada, formerly a large and populous town, is now a miserable village, with a population of some three hundred souls.

The inhabitants of these two kingdoms were essentially commercial, and acted as middle-men between the inland tribes and the Europeans who frequented Whydah in their ships. Of these interior tribes, Dahomi, about 1625, became the most prominent. It gradually subjugated the surrounding peoples, and, in 1723, Guadja Trudo, the then King of Dahomi, was sufficiently powerful to demand of the Ardras a right of way and free traffic to the sea. The Ardras refused. The Dahomis invaded their territory in 1724, defeated them in a great battle, and the kingdom of Ardra was at an end. Three years later, in February, 1727, Guadja Trudo made a similar demand upon the Whydahs; the king of the latter also refused compliance: his territory was at once invaded and the kingdom overthrown. These two invasions fix for us the date at which snake-worship was introduced into Hayti; for thousands of Ardras and Whydahs, prisoners of war, were sold to the slave-traders and shipped across the Atlantic. For a good many years before the downfall of these kingdoms Whydah had been the chief, probably the only, slave emporium of the Slave Coast, and large numbers of slaves had thence been exported; but these earlier slaves had not been Ardras and Whydahs, among whom alone the python-worship prevailed; they were Mahis, and members of the various small tribes which had been defeated by Dahomi, and whom the people of the two seaboard kingdoms had bought from the latter to sell to the white men.

It was, then, the war captives taken at the conquest of Ardra and Whydah who brought both the word võdu and the snake-worship into Hayti; and if it be asked how it is that the other

West Indian Islands are at the present day free from every trace of the *cult*, the explanation is ready. The English supplied their colonies with slaves from their forts on the Gold Coast, and the great majority, so great as to comprise almost all the slaves imported into the British West Indies, were what were called, in the jargon of the slave trade, Coromantees, a designation which was a corruption of the name of a town called Acromanti, situated some fifteen miles to the east of Cape Coast Castle, and where the first English fort on the Gold Coast was built. These Coromantees, all members of the Tshi-speaking tribes—the Ashantis, Denkeras, Akims, Assins, Fantis, etc.—were noted for their superior physical strength, and for their ferocity and rebellious disposition. Every slave rebellion in the British West Indies, from the first in Jamaica in 1690 to the last in 1831 in the same island, was a rebellion of Coromantees; and their dangerous character was so well known that other nations did not care to purchase them. The Royal African Company had a treaty with Spain by which it undertook to supply the Spanish colonies with Eboe or Ibo slaves from the delta of the Niger, who, though of inferior physique, were preferred on account of their docility; and the French obtained their slaves principally from Whydah, though partly also from Senegal. Hence the great mass of Ardras and Whydahs were shipped to the French West India Islands, and no doubt the snake *cult* was introduced into Martinique and Guadeloupe as well as into Hayti. All such võdu or "fetich" practices were, however, sternly suppressed by the planters, partly because they themselves feared them and had a superstitious belief in their power for evil, but principally because it was by their means that the more restless and uncontrollable slaves instigated their more docile brethren to rebel. There was the religious element at the bottom of every outbreak, and consequently all võdu practices were forbidden under heavy penalties. But such superstitions die hard; and though we do not now hear of any võdu-worship in Martinique and Guadeloupe, yet it is probable that, if the negroes of those islands had succeeded in achieving their independence, we should find it in as full vigor there as we do now in Hayti.

At the date of the overthrow of Ardra and Whydah, Louisiana was also a French possession, colonized by the French Mississippi Company; so we might reasonably suppose that some Ewe-speaking slaves were introduced there also, though it seems that the colonists obtained a great many from English slave-traders. But in 1809 a large number of French planters with their slaves, who in consequence of the insurrection in Hayti had sought refuge in Cuba, were compelled by the outbreak of war between France and Spain to quit their asylum, and landed in New Orleans. There were about five thousand eight hundred in all, whites, mulattoes, and slaves, and the latter, no doubt, brought into Louisiana the word vōdu and the snake-worship.

That the Ardra and Whydah slaves should have clung more tenaciously to the worship of their snake-god than to that of the other deities of their native country is explained by the fact that the python-god was the national god. According to existing tradition, the people of Whydah advanced the python to the dignity of their chief tutelary deity on account of the signal services it rendered when they were attacked by some powerful foe. Overwhelmed by superior numbers, they were giving way in every direction, when all at once the python-god appeared in the broken ranks, caressed the warriors with his head and tail, and inspired them with new courage; so that, when the chief priest raised the god on high at arms' length, and showed him as a guarantee of victory, the Whydahs rushed forward in a frenzy of enthusiasm, swept back the foe and utterly routed him. It was on account of this service, says the tradition, that the Whydahs built at Savi an elaborate temple, in which the priests professed to keep the very snake who had brought them victory. So confident were the Whydahs in the power of their god that, on the approach of the invading Dahomi army in 1727, instead of concentrating their forces at the lagoon to the north of Savi, which was only fordable at one point and on a narrow front, and so might easily have been held against superior numbers, they remained quietly at home and confided the defense to a python, which they placed on the southern bank. The Dahomis soon discovered this, crossed the lagoon without opposition, killed the python, and captured Savi.

The Dahomis treated the snake-gods with contempt, and destroyed the temple at Savi, but they did not prohibit the worship; and the remnant of the Whydahs who escaped the slaughter of the conquest continued it, with the result that after a quarter of a century or so the more southern Dahomis adopted the worship themselves. Some fugitives from Ardra, who fled to the eastward and founded the kingdom of Porto Novo, a new Ardra as it was then called, established the worship there; and these places, with Agweh and Little Popo to the west, to which the *cult* has within the last half-century spread from Whydah, are the only ones in which python-worship prevails.

The name of the python-god is Dañh-gbi (*dañh*, snake, and *agbi*, life). He is the god of wisdom, to whom all things are known, and, as he opened the eyes of the first man and the first woman, who were blind, he is the benefactor of mankind. He must not be confounded with the Great Snake of the Heavens, Anyiewo, sometimes called simply Dañh, who is the Rainbow-god. Dañh-gbi has his own order of priests, and, like all the chief gods of the Ewe-speaking peoples, numerous "wives," *kosio*—that is, women dedicated to his service, who tend the temples, and on holy days and festivals give themselves indiscriminately to the worshipers of the god. The ranks of the *kosio* are recruited by the affiliation of young girls, who are received in a kind of seminary, where they remain for three years, learning the sacred songs and dances and other matters appertaining to the worship. During this novitiate they may only be visited by the priests, but at its termination they practice openly as *kosio*. This is the ordinary mode of becoming a *kosi*; but any woman whatever, married or single, can, by publicly simulating possession by the god, by uttering the conventional cries recognized as indicative of possession, at once join the body. In this case she likewise undergoes a three years' novitiate, during which she is forbidden, if single, to enter the house of her parents, and, if married, that of her husband. The *kosio* of Dañh-gbi usually appear with the bosom smeared with palm oil, but their distinguishing mark is a necklet, called *adunka*, made of the twisted filaments of a sprouting palm leaf. On ceremonial occasions they wear a fillet of the same material, with anklets, armlets, and neck-strings of cowries. The remainder of their costume consists of a strip of cotton print hanging from the waist and barely reaching to the knee. They are most licentious; and the festivals, which are usually kept up all night, present a horrible scene of drunkenness and debauchery. As is the case with the women attached to temples in India, this life of prostitution is not considered dishonorable, because it is regarded as part of the service of the religion. The *kosio* are, indeed, not considered as responsible for their actions. It is the god, say the people, who inspires them at such times.

When a follower of the python-god wishes to have the advantage of his advice and assistance, he has recourse to a priest, who fixes and receives the fees and appoints a day for the ceremony. Such consultations of the oracle, so to speak, are always public. The person seeking the aid or counsel of the god comes with all his relatives and friends; the priest and *kosio* turn out in force and parade the sacred drums and temple paraphernalia; and then, in the open space in front of the temple, the priest becomes inspired and gives vent to the oracular utterances. The indwelling spirit of the python enters the body of the priest and speaks through his mouth, in a strange, unnatural voice. Some honest, though perhaps hysterical, priests really do work themselves up into a condition of frenzy, by means of the violent and extraordinary dance which is always the main feature of such exhibitions; and the dishonest ones, who form the great majority, foam at the mouth and simulate as well as they can the symptoms of an epileptic seizure, which here, as among most other uncivilized communities throughout the world, is regarded as the effect of a god, or devil, having entered the body. It is perhaps needless to say that the oracle is nearly always ambiguous. "If Dañh-gbi be propitious, you will attain your object," is a reply commonly heard. If the applicant should fail, then the priest naturally explains that Dañh-gbi was not propitious; perhaps he had been offended by something, or perhaps the offerings were insufficient; and if he should succeed, then the priest claims the result as being entirely due to the intervention of the god. In this respect, it will be observed, the practice of the Ewe priest does not materially differ from that of the expounders of higher religions. The sacred dance is always performed to the sound of the sacred drums, on which is played a rhythm peculiar to the god. The whole ceremony of "possession" is exceedingly curious, but for further details I must refer the reader to Chapter X of my Tshi-speaking Peoples of the Gold Coast, where will be found a description which applies in all essential particulars equally well to the Ewe-speaking peoples.

The Dañh-gbi we—"House of Dañh-gbi"—or Python Temple at Whydah, which is the most important of its kind, is a circular structure with walls of "swish" or kneaded mud, and a conical roof thatched with grass, a privilege accorded to shrines and temples only, all other buildings being required to be roofed with palm thatch. It stands in a small rectangular inclosure near the center of the town, and around it are the calabashes and shallow earthen vessels containing water, palm wine, palm oil, cowries, fowls, and other offerings. A few sacred trees stand in the inclosure, and long strips of white cotton fluttering from bamboo poles indicate the sacred character of the spot, for white is the color belonging to the võdu. The pythons, usually from fifty to eighty in number, live in the temple, but have free exit, holes being made in the mud walls to enable them to pass in and out. They are allowed to wander anywhere about the town, and are only carried back to the temple when they happen to enter some profane locality, such as the yard of a European trader. In such a case a priest goes to fetch the god, prostrates himself before it, apologizes for the liberty he is about to take, and then, raising it gently in his arms, carries it home. When a lay native meets one of these snake deities in his path, he prostrates himself in front of it, rubs his forehead on the earth, and covers himself with dust which he throws on his head and shoulders with both hands. "You are my father—you are my mother!" he cries. "My head belongs to you. Be propitious to me."

Opposite to the Dañh-gbi we are the schools or seminaries where the *kosio* live, and where any child who may chance to touch, or be touched by, a python has to be kept for an entire year, at the expense of the parents, and learn the songs and dances proper to the worship. In former days adults were similarly liable, especially women; and not even the daughters of influential chiefs were exempt. The scandals that resulted from this—for the *kosio* seminaries are chiefly schools of debauchery—and the decline of the priestly power during the last thirty years, have now, however, led to the penalty being restricted to children.

Fifty years ago any native who killed a python, even by accident, was burned to death; and even Europeans have been killed for having thus offended the religious prejudices of the Whydahs. At the present day, though the appearance of carrying out the old sentence is preserved, the culprit is allowed to escape with life. To keep up the form, he is confined in a small hut made of dried grass, which at a given signal is fired on all sides. The man bursts forth, and is then attacked with sticks by the worshipers of Dañh-gbi, who rain blows on his head and shoulders, until he succeeds in reaching water, which bars him from further attack.

There are days consecrated to Dañh-gbi, when great processions are held, and which are remarkable for many curious ceremonies, too lengthy, however, to be described here. During one procession every house is closed, and the people are forbidden to be abroad in the streets or to peep from their windows; and all processions are ushered in by a general slaughter of all hogs found at large, which are pursued and beaten to death by bands of priests armed with clubs, for the hog is a sacrilegious animal, even capable of devouring a python-god, should he find an opportunity. White ants are the messengers of Dañh-gbi, and their nests may often be seen encircled with palm leaves, to indicate that the inhabitants are in his service. Many people still believe that the traditional python, which turned the tide of victory in favor of the Whydahs, still lives. It is believed to inhabit a gigantic tree hidden in the depths of a vast forest, and to climb every morning to the topmost branch, coil its tail round it, and hang head downward toward the earth. When it is sufficiently long to reach the earth with its head, it will, say the natives, be able to reach the sky and climb up into it.

Such, briefly sketched, is snake-worship, as it exists on the Slave Coast at the present day; and, if we may judge from the descriptions given by old voyagers, it has not changed in any important particular since the downfall of the kingdoms of Ardra and Whydah. Let us now turn to the worship as it is found in Hayti and Louisiana. It will be perhaps more convenient to examine it in detail.

Sir Spencer St. John, apparently following St. Méry, says (p.

186 *et seq.*) that the "Arada" negroes are the true sectaries of "vaudoux" in Hayti, and that the word "vaudoux" signifies an all-powerful and supernatural being, on whom depend all the events that take place in the world. This being only consents to communicate with his worshipers through a high priest, and still more through "the negress whom the love of the latter has raised to the rank of high priestess." These two are called the king and queen. They are the chiefs of the sect, decide who shall be admitted to the society, receive the gifts offered to the god, and, being the interpreters of his will, naturally have great power.

Let us look into this first. As has already been stated, the word vōdu should not properly be limited to the snake deity, and in Africa Dañh-gbi is not supposed to control the affairs of the world. He is simply the god of wisdom and the benefactor of man, the natural phenomena being under the control of other gods. There is on the Slave Coast nothing answering to the king and queen found in Hayti, but some such change might be expected, for it is improbable that any of the regular priesthood were shipped across the Atlantic as slaves. In the intertribal wars of the present day it seems to be the invariable rule to enslave the masses and to strike off the heads of all chiefs, priests, and men of eminence, whose skulls are carefully preserved, partly as trophies and partly in order that the victory may not be forgotten. From all the evidence now obtainable this seems to have always been the custom; and, as Captain Suelgrave tells us that four thousand prisoners of war were sacrificed at the conquest of Whydah, it is probable that the "classes" were used up in this manner. In Hayti the king takes the place of the Slave Coast priest, and the queen is seemingly the result of a confused recollection of the institution of the *kosio*. In both places the priests are the mouth-pieces of the god, who can only be consulted through them. Of course, this must necessarily be the case wherever there is a priesthood which depends upon the people for a livelihood; for, if any and every individual could consult the gods himself, the office of priest, or mediator between god and man, would be superfluous.

To epitomize further from St. John: In Hayti the reunion of worshipers never takes place except secretly, in the dead of night, and in a place safe from any profane eye. There is an oath of secrecy, which is the foundation of the association. Red seems to be the favorite color, the king and queen wearing handkerchiefs in which it predominates. The snake is present, confined in a box. The meeting commences by adoration of the snake, by protestations of being faithful to its worship and submissive to its commands. Then, those who wish to consult the god, and ask his aid and assistance in any matter they may have at heart, come forward in turn. The king takes the box containing the snake, and commands the queen to stand on it. "She trembles, all her body is in a state of convulsion, and the oracle speaks by her mouth." Sometimes she promises success, sometimes the reverse; at others she dictates a certain procedure to be followed; generally there is a certain amount of ambiguity in her utterances. After the consultations comes the "vaudoux" dance—that is, the dance proper to the worship. It is performed by the worshipers generally, who imbibe copious draughts of spirituous liquors; and the night terminates in a scene of disgusting debauchery. Those who consult the god bring offerings, and the proper sacrifice is a white fowl or a white goat.

This very closely resembles the proceedings on the Slave Coast. The simulation of possession or inspiration by a god always commences with a violent trembling of the whole body, followed by convulsive movements, during which the "oracle" speaks. White fowls and white goats are to this day the proper offerings to Dañh-gbi at Whydah; and the sacred dance, with its accompanying drunkenness and final midnight debauchery, is what may be seen during any festival. The secrecy which attends the ceremony in Hayti is of course the natural result of the French laws for the repression of the *cult*. Bosman (A. D. 1705) says that red was the royal color at Ardra, which is the probable reason of its being the favorite vōdu color in Hayti.

The description given by St. John (p. 191) of the ceremony observed for the admission of a new member to the sect hardly differs at all from what may be seen at the present day on the Slave Coast when a man joins the priesthood. A candidate for the priestly office undergoes a three years' novitiate like the *kosio*, at the end of which time he is required to show, by being publicly inspired or possessed, that some god accepts him and considers him worthy of his service. For this test a circle is traced on the ground, images of the different gods are set at regular intervals round the circumference, and the would-be priest is set in the middle. The drums strike up the rhythm of the sacred dance, and the candidate commences his performance, dances wildly and violently, and then goes through the form of possession, foaming at the mouth and trembling from head to foot. While in this condition he comes in contact with one of the images which surround him, and this indicates the god who has found him worthy. The idea, of course, is that the possessing god causes the candidate to touch the image; and to cross the circumference of the circle without coming into contact with one is a very bad omen. In Hayti the circle is traced, but no images or emblems of the gods are placed round it, because only one god is concerned; there is no question as to which god the candidate is to serve. Then, too, to leave the circle during possession is equally considered a bad omen.

Vōdu-worship in Louisiana does not seem to differ much from the above, except that the office of king has almost disappeared, and that the queen is paramount. In both places it is the worship of the Whydah Dañh-gbi in a disintegrated condition, the disintegration being caused by the disruption of the *cult* from its proper habitat and surroundings, by the repressive measures enacted by the French, which caused new features to appear, by the altered condition of the worshipers, and especially by the disappearance of the established and regular priesthood. Hence a confusion of ideas, which has caused the Haytians to drift somewhat from the true *cult;* but that they know whence they obtained it seems certain, for St. John found in a vōdu temple a flag of red silk, on which was embroidered, "Société des Fleurs za Dahomïan." This flag was said to have been the gift of the consort of Soulouque, the Haytian "emperor"; and the fact that such a statement could be openly made and generally believed is significant of the extent to which Haytian society is permeated by this barbarous religion.

One of the most striking results of the confusion of ideas is the grafting of human sacrifices and cannibalism upon the worship of the snake-god, which, in Africa, has no connection with either of these practices. This innovation is, it seems, not universally accepted, for St. John says that there are in Hayti two sects of "vaudoux" worshipers, one of which, perhaps the least numerous, offers human victims and indulges in cannibal feasts; while the other holds such practices in abhorrence, and is content with the white goat and the white fowl, the proper sacrifices of the African *cult.* The Haytians term the sacrifice of a human victim the offering of "the goat without horns," a euphemism for which we can find many parallels. Louisiana is, fortunately, free from this horrible taint, but, from the numerous instances given by St. John, there can be no doubt that the immolation of young people, generally girls, is not uncommon in Hayti. At page 193 he tells us of a scene witnessed by a French priest in the district of Arcahaye in 1869. This man had persuaded some of his parishioners to disguise him as a negro, and to take him to witness the vōdu ceremonies All went on in the manner that has already been described till after the sacrifice of a white goat and fowl, when a young man came and knelt before the queen and said: "O maman, I have a favor to ask. Give us, to complete the sacrifice, the goat without horns." The queen gave a sign of assent, the crowd in the shed separated, and there was a child sitting with its feet bound. In an instant a rope, already passed through a block, was tightened, the child's feet flew up toward the roof, and the king approached it with a knife. The loud shriek given by the victim aroused the Frenchman to the truth of what was really going on. He shouted, "Oh, spare the child!" and would have rushed forward, but he was seized and hurried from the spot by his friends. There was a short pursuit, but he escaped, and, on reaching the town, strove to induce the police to hasten to the place. They would, however, do nothing till the morning, when they accompanied him to the scene of sacrifice, and found the remains of the feast and the boiled skull of the child.

During the government of President Geffrard, a determined opponent of vōdu practices, four men and four women were tried and convicted of the sacrifice of a young girl, whose body was afterward eaten by the worshipers. The overthrow of Geffrard was said to have been the result of the measures he took to stamp out these atrocities, and since his time no President, except Boisrond Canal, appears to have had the courage to attack them. According to St. John, these practices are rapidly gaining ground, and are now scarcely even concealed.

The only native god of the Slave Coast whose worship is in any way connected with cannibalism is Khebioso, the lightning-god, who in the eastern districts, abutting upon the Yomba country, is commonly known by his Yomba name, Shango. In bygone days it used to be the duty of the priests and *kosio* of Shango to cut up and eat the bodies of all persons killed by lightning, but at the present day the practice has fallen into desuetude. If the person killed be a freeman, the priests place the corpse on a raised scaffolding of sticks, and, after making all preparations for cutting it up, suffer the relations to ransom it; but where the deceased is a slave, whose body no one would care to ransom, the *kosio* cut from the corpse large lumps of flesh, and chew them, without swallowing, crying to the passers-by, "We sell you meat—good meat." As human sacrifices are frequently offered to Shango, it seems probable that the sacrifice of "the goat without horns," and the subsequent cannibal feast, are really derived from the worship of the lightning-god; and that, owing to the absence of distinct orders of priests in Hayti, the two practices became grafted, by one sect of vōdu-worshipers, upon the worship of the snake deity. This view is supported by what St. John says (p. 195) of some curious polished stones, which were shown to him by a French priest, and which formed part of the relics worshiped by the vōdu sect. One of these was a stone axe in the form of a crescent, and all implements of the stone age are, on the Slave Coast, sacred to Shango, whose thunderbolts (*so-kpe*, "fire-stone") they are believed to be. In fact, whenever a house is struck by lightning, a mob of priests, *kosio*, and worshipers of Shango rush into it and plunder it, while pretending to search for the sacred stone. When the house is stripped the priests produce a stone implement, generally an axe, which they pretend to have found, and which justifies their pillage. Blood, mixed with rum, is commonly drunk by the votaries of Shango on days of festival; and this is the drink used in the secret ceremonies of the cannibal "vaudoux" worshipers of Hayti.

In the Century Magazine for April, 1886, Mr. George W. Cable mentions some "voodoo" charms; but these have no connection at all with python-worship. They are superstitious practices, such as are found everywhere; survivals of the religions which gave birth to them, and in which each had a definite meaning and intention. Thus, on the Slave Coast, each god has his own distinguishing badge or amulet, made by his priests and sold to his worshipers, who wear them so that the god may be reminded that they are under his protection. From the priests of malevolent gods people can also obtain charms to work evil; and these are either harmless rubbish, such as parrots' feathers tied together, small bunches of human hair, etc., or powders which are reputed to possess magic properties. To keep up the reputation of the efficacy of such preparations, the priests occasionally secretly supplement them with poison, which they contrive to have placed in the food of the person against whom the spell was directed; and the purchaser, finding that his enemy has died, attributes it to the action of what he obtained from the priest, and consequently regards all such preparations with great dread. The hollowed-out acorn, mentioned by Mr. Cable, seems a copy of the cutch-nut charm of the Gold Coast, whose chief use there, however, is to restrain the slanderous tongue; the dough or waxen heart, stuck full of pins, is evidently an idea borrowed from mediæval witchcraft; and the pouring of champagne on a moonless night at the four corners of a square seems a corruption of the form of invocation of Shugudu, a malignant god, who will lend his aid to any one who on a dark night will pour a libation of rum into a hole dug in the ground, or bury a fowl alive.

The different words given by Mr. Cable, as used in connection with võdu-worship, are difficult to identify; they have, no doubt, changed at least as much from the original as the creole French has from European French. As the word *võdu* and the snake-worship are both peculiarly Ewe, one might expect to find words belonging to that language predominating; so, at a guess, one might suppose the words *tigui li*, in the võdu song, given at the foot of page 820, to be *tigewola*, "a maker of charms," or "medicine-man"; and the concluding sentence, *Do sé dan go-do*, to be *Do dsi dañh godo*, "O curved snake, may you be fat," i. e., "have a good meal." This, however, is mere conjecture, for the word *papa* in the same song, if not French, is the Tshi adjective "good," and not Ewe at all; while the words *Héron mande* defy solution. *Maignan*, or *magnan*, an epithet of the võdu, may be a corruption of *amãga*, "the old, the venerated," or even of *Dañh-gbi* itself. I have seen a corruption nearly as bad; that of the Tshi *nyan-kupoñ*, to *accompong*, in Jamaica, for instance. These are, however, evidently words belonging to other languages now mixed up with the võdu *cult* in Louisiana. One such is *wongah*, used in Louisiana to mean a võdu charm, and which is most probably the Gã term *wong*, "a charm." The words in the song *Dé-zab*, at page 827, appear to be Tshi, but I should never have been able to identify them without the translation, "Out from under the trees our boat moves into the open water." By its means, however, "*Day zab, day zab, day koo-noo wi wi. Koonoo wi wi momzah*," may be taken to be really *Des arbres, des arbres, de canoe wiwi. Canoe wiwi miombah*—"From the trees, from the trees, the canoe, stealthily. (In the) canoe, stealthily, let us come." The word *rozah* is unintelligible; in the Tshi language there are no words commencing with *r*, or with that letter with which *r* is so frequently interchangeable, *l*. It would be, however, mere waste of time to look further into this jargon, in which French, Ewe, Effon, Tshi, and Gã words are certainly—and Yomba, Ibo, and Congoese words most probably—indiscriminately mixed together, and so distorted as to render positive recognition almost hopeless.

THE RELATIVE VALUE OF CEMENTS.

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IN The Popular Science Monthly of June, 1890, page 253, there appeared an article entitled Natural and Artificial Cements, by Prof. La Roy F. Griffin, in which theories were advanced in regard to the setting of cement which are at variance with the chemical reactions that are known to take place. There were also given the results of some cement tests, with deductions from the same, that not only are contrary to the results obtained by other experimenters, but are also contrary to the results obtained from the use of cements in works of construction. That there are so many points in Prof. Griffin's article to which exception must be taken, and the exceedingly false impression his article would leave upon the public as to the relative value of

American cements, both natural and artificial, is the excuse of the writers for the following article. The diagrams and tables given have been compiled from results obtained in an extended course of cement tests now in progress in the Engineering Department of the State University of Iowa.

Cements, such as are used for constructive purposes, may be divided into two general classes, natural and artificial. The essential ingredients, carbonate of lime, silica, and alumina, are the same in both classes, the principal difference being the proportions in which they are present, and their purity.

In the manufacture of natural cement the raw material generally used is some stone in which the carbonate of lime, silica, and alumina are present in more or less correct proportions, while in the manufacture of the artificial cement the raw material used consists of the essential ingredients, each in a comparatively pure state, thoroughly mixed in theoretically the correct proportions. It is due to this fact that artificial or Portland cement is not only much superior to natural cements, but that it is much more uniform in its quality. This feature of uniformity is perhaps the most valuable possessed by Portland cements, and one which can never be attained in the manufacture of natural cements.

The term Portland cement is now generally used to designate artificial cement, from the fact that the first artificial cement made in England, when hardened, resembled the famous Portland building-stone.

Whether the mixture of the necessary ingredients is artificial or not, it is burned almost to the point of vitrification and then ground to an extreme fineness. The fineness to which cement is ground is one of the most important points in its manufacture, for the reason that, if not finely ground, its strength may be reduced fifty or seventy-five per cent. The theory advanced by Prof. Griffin, on page 254, in regard to the setting of cement, namely, the absorption of carbon dioxide, the uniting of this gas with the lime, and the reforming of lime-stone, is simply the old *lime-mortar* theory, and in no way applies to the setting of cement. In regard to the changes that do take place during the setting of cement, the following quotations from an article upon the subject by Dr. L. W. Andrews and F. W. Spanutius, in The Transit for December, afford the clearest explanations:

"The setting of a cement is, in general, a complex process, partly chemical in its nature, partly mechanical. Broadly stated, the chemical changes which occur may be said rather to afford opportunity for the mechanical changes which result in hardening than themselves to cause the hardening. The chemical changes are, therefore, susceptible of wide variation without materially influencing the result. . . . In some cements, of which plaster of Paris may be taken as the type, water simply combines with some constituent of the cement already present. In others, of which Portland cement is the most important example, certain chemical reactions must first take place. These reactions give rise to substances which, as soon as formed, combine with water and constitute the true cementaceous material. Portland cement contains as chief, sometimes as almost sole constituent, a lime peridote, and in addition a tricalcium aluminate, $Ca_3Al_2O_6$, soluble in 3,000 parts of water, and a dark-brown fusible substance, $Ca_6Al_2Fe_2O_9$. In the act of setting, the tricalcium aluminate first dissolves in water and then begins to separate again as a mass of felted needles consisting of calcium aluminum hydrate, which extend in every direction and are directly the cause of the first setting of the cement. At the same time an action begins which requires a much longer time for its completion, and which probably consists in a combination of the first formed aluminum hydrate with the calcium peridote and the water, forming a mineral belonging to the zeolite class and possessing very probably the composition $H_{10}CaAl_2Si_4O_{17}$. This zeolite crystallizes out as it forms, and this continues, for long periods subsequent to the first setting of the cement, to add to its solidity and tenacity."

Following the reasoning of Prof. Griffin, we are unable to understand the meaning of "pure lime cement," as the two terms "pure lime" and "cement," when used in an engineering sense, are incompatible. The effect of the presence of magnesia upon the quality of cement is not perfectly understood; but that an increased hardening in cement for a long period of time is due alone to its presence, is not so, as cements that contain no magnesia have been known to improve constantly during a period of two years.

To quote from Prof. Griffin:

"So a Portland cement will develop its full strength in a few months, while our natural cements will not for years, and, so long as it (this chemical action) continues, the structure improves."

Unless Prof. Griffin classes Portland cement as a "pure lime cement" (which it is not), he has advanced no proof of the above quotation; and furthermore this statement itself is incorrect. It is a fact well known to all engineers and builders that as a class Portland cements are slower setting than the natural cements; and also that natural cements attain their full strength within a comparatively short time (within the first year as a maximum limit), and that, after the full strength has been attained, this strength may decrease, as time goes on, in some natural cements. There has, however, been found no limit of time beyond which Portland cement deteriorated, and for two or three years at least it improves its strength.

In speaking of cement testing, Prof. Griffin says:

"No one of these" (meaning tests for compression, tension, torsion, and cross-strain) "can be dispensed with, since material that will endure one satisfactorily will utterly fail in another; . . . but for general purposes the test of cement which is the most valuable is that which determines its tensile strength."

There are very few cases in practice where any tests other than for tension are made. The statement that "no one of these can be dispensed with," etc., is contradicted by what follows, that the most general test is for tensile strength.

From the very nature of cement, these necessary qualities are so dependent one upon the other that practice and experiment have shown that, where one of these physical tests is passed satisfactorily, the others within certain limits must also be satisfactory. It is due to this fact alone that tests for tensile strength are accepted as standard, as in construction cement should never be subjected to tension or cross-strain, but is usually subjected to compression, or possibly in some cases to torsion; but because the compressive strength in cement is generally proportional to its tensile strength, tension tests have, on account of the facility and accuracy with which they can be made, been adopted as standard.

The form of the test briquette given by Prof. Griffin is not that approved by the American Society of Civil Engineers and adopted in all standard cement tests. The approved form of briquette is that shown in Fig. 1.

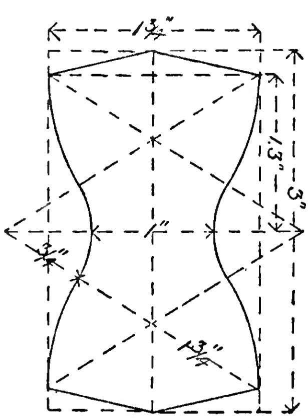

Fig. 1.—Standard Form of Briquette, One Inch in Thickness.

These briquettes are usually made by hand, as described by Prof. Griffin. But unless a great deal of help is available, the process is much too slow for any very extended series of tests; the amount of mortar that can be mixed at once is small; and where different persons are employed it is impossible to obtain briquettes that give satisfactory comparative results, owing to the difference in the personal equations of the makers. This was soon found to be the case in the "State University of Iowa" cement tests, and a specially designed machine was built, having a capacity of making over three thousand briquettes per day, being run by two men. This made possible the making of a much greater number of briquettes under practically the same conditions. Owing to the greater amount of pressure machine-made briquettes are subjected to (about one hundred and fifty pounds per square inch), they are probably stronger than the hand-made; but, as this pressure is uniform for all the briquettes, which is not the case when they are made by hand, the comparative value of the tests is far superior to anything attainable by hand-made briquettes. The following table shows the difference in tensile strength between hand- and machine-made briquettes. Each result is the mean of ten briquettes broken at the end of six months:

NAME OF CEMENT.	Hand-made.	Machine-made.
Neat Milwaukee (American)	333	346
" Gibbs's Portland (English)	609	703
" Buckeye Portland (American)	669	844

All the briquettes used in the tests from which the table and diagrams here given were taken were allowed to stand twenty-four hours in the air, and were then immersed, the time of immersion being the zero marked upon the diagrams, and all the periods of time being reckoned from this point in weeks, which are noted along the bottom of the diagram. A number of briquettes were broken each day for the first seven days; after this a number was broken every seven days, and the average of these results giving the ordinates to the line on the diagram. Besides these briquettes, ten extra ones were broken at the expiration of one week, one month, three months, and six months. The average of the tensile strength of these, and the time of breaking, are shown on the diagram by black dots, the letter showing the brand of the cement: M, Milwaukee; U, Utica; G, Gibbs English Portland; and B, Buckeye American Portland. This system of breaking briquettes shows the effect of time upon their strength. The testing-machine used in these tests was Riehle Brothers' "Standard Cement Tester," in which the strain upon the briquette is gradually increased by means of a screw-and-worm gear. Although the type mentioned by Prof. Griffin possesses accuracy, and is very satisfactory, still the Riehle machine gives equally satisfactory results, and allows of a much greater number of briquettes being broken within a given time.

Any comparison of the relative value of cements based upon their percentage of increase in strength, as made by Prof. Griffin, is of no value. A cement that attains a certain strength in seven days, even if it only increases one per cent during the following ninety days, is superior for constructive purposes to one that increases four hundred per cent during the same time, provided the ultimate strength of the latter is not greater than the former.

The strength of Milwaukee cement, of which Prof. Griffin has much to say, can be seen in the diagram, as compared with the other brands of cements given. The table given by Prof. Griffin, to illustrate the superiority of Milwaukee cement, shows that the strength of the Milwaukee was three hundred and eighty-two pounds per square inch at thirty days, and only three hundred and fifty pounds per square inch at sixty days. This hardly proves either the superiority of Milwaukee, or that natural

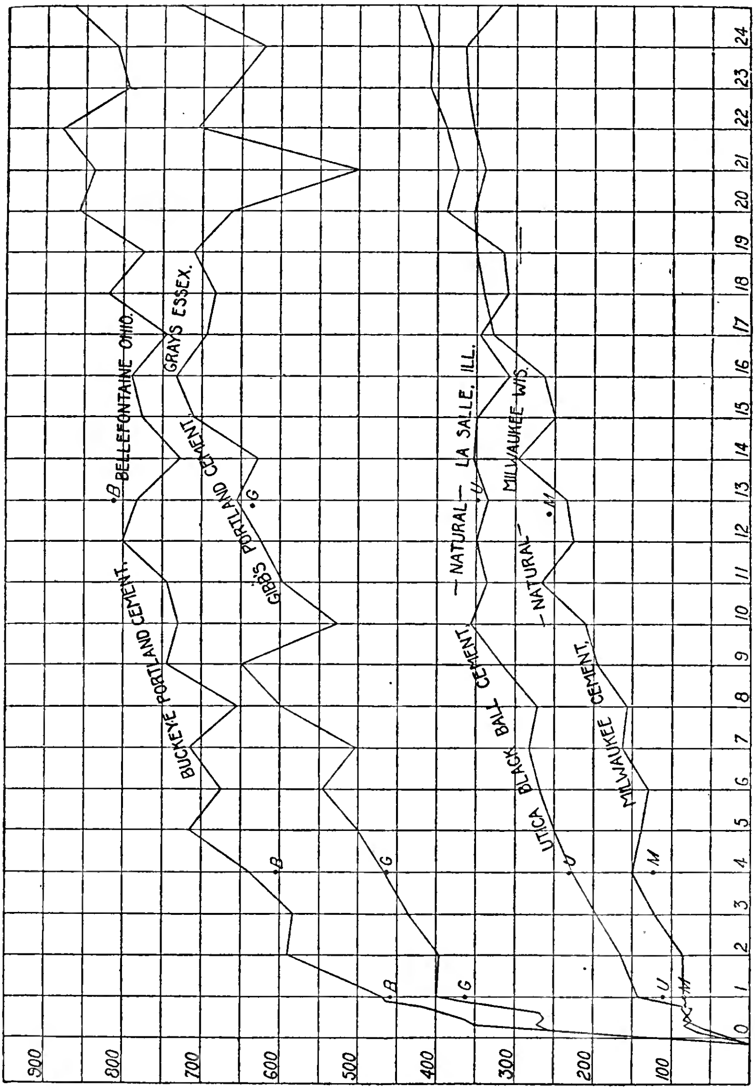

Fig. 2.—Diagram showing the Relative Tensile Strength of English and American Portland and Two Brands of American Natural.

cement increases in strength with age; and, as it is the average of seventy-five specimens, would rather seem to disapprove the points mentioned. It is true that briquettes made of the same cement, at the same time, kept under the same conditions, and broken at the same time, show a great variation in tensile

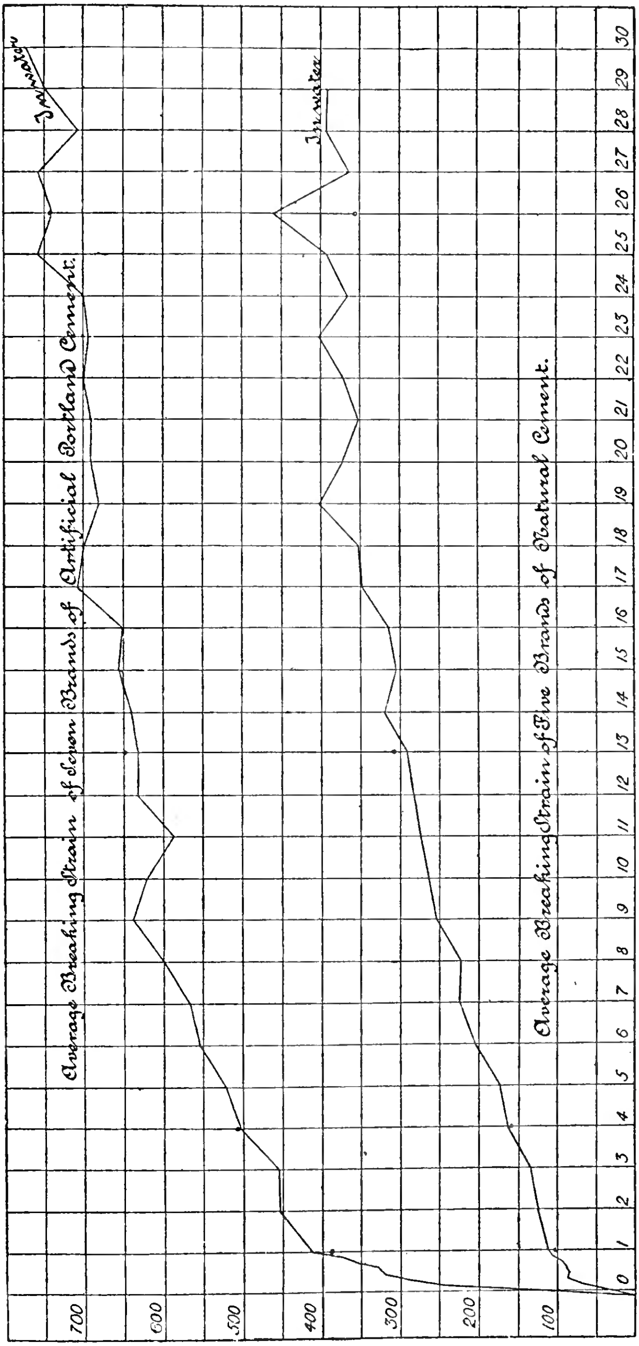

FIG. 3.—DIAGRAM SHOWING THE RELATIVE TENSILE STRENGTH OF NATURAL AND ARTIFICIAL CEMENTS.

strength. The statement of Prof. Griffin that Milwaukee cement has been shown to have the greatest crushing strength is rather too sweeping, to say the least, as all first-class Portland cements are superior to Milwaukee in this respect, and there are a number of brands of American natural cements that are in every way its equal. Although English Portland cements are among the best in the market, still they are equaled by both German and French Portland, while there are now manufactured in the United States Portland cements that in tensile strength exceed any imported cements. Briquettes made of American Portland have shown a tensile strength of eleven hundred pounds at the end of twenty-six weeks.

A careful study of the diagrams will give a correct idea of the relative values of typical English and American Portland cements, American natural cements, and Portland and natural cements. It is not intended to show in Fig. 2 that Milwaukee cement is inferior to all American natural cements, but simply that there are American natural cements that under the same treatment will give at least as good results. The numbers along the bottom of the diagrams indicate the age of the briquettes in weeks; the numbers at the side indicate pounds.

ADAPTATION TO CLIMATE.

By M. SAINT-YVES MÉNARD.*

THE object of the acclimatation of animals and plants is to add to the species, races, and varieties of a country species, races, and varieties of other countries that may be useful or simply agreeable to it, whether they be represented in the wild or the domesticated state. The history of the subject is not complicated. It is a general fact that the sciences which we now have to study before entering into the practice of the arts originated after considerable applications of them had been made. They cultivated wheat long before agronomical institutes were founded; iron was extracted from its ores before metallurgy was known; we took care of the sick—and some pretend that we cured them—before the science of medicine existed. So we domesticated wild animals and took them from country to country, from climate to climate, before we had a science of acclimatization to direct us. But while most of the sciences originated in the distant past, the science of acclimatization is new. Something is indeed said on the subject in the books of Buffon, Bernardin de Saint-Pierre,

* From a Lecture before the Société de Médecine Pratique.

and other authors; and two important acclimatizations—that of the merino sheep by Daubenton, and the introduction of the potato to general use by Parmentier—were made or brought to completion in the eighteenth century, but these were isolated circumstances. The systematic, methodical, deliberate thought of looking out in behalf of any country for animals and plants that might be of profit to it, and of making a study of their value and of the means of making them at home in their new abode, was originally conceived by Isidor Geoffroy Saint-Hilaire. His studies were first directed to this point in 1829, after which they constantly held the most prominent place in his mind. He founded the Society of Acclimatation, for propagating this idea and giving it practical force, in 1854; and five years later, in 1859, in co-operation with that society, he created the zoölogical *Jardin d'Acclimatation* for the purpose of applying the idea to new species, and of studying the conditions under which they could be best made to thrive.

We may divide the history of acclimatation into two periods: one immensely long, beginning with the first domestications of animals and the first migrations of men—a period of practice without science, which was nevertheless fruitful; and the other, which is as yet only a half-century long, of scientific acclimatation. We may also consider the subject with a view to its utility, and to the results that have been achieved in it and the encouragement it offers for the future.

To the first period we owe nearly all our domestic animals and cultivated plants. If we inquire into the origin of our domestic animals, we shall find that twelve of them came from Asia, two from Africa, and three from America, while five are European. If we only had what Europe has furnished us, our list would be reduced to the pigeon, duck, goose, rabbit, and bees. Our farmsteads would then be only modest poultry-yards, and our fields would not be cultivated. It is true that we should not have much occasion to cultivate anything, if we had to leave off from our list of plants all that are not native to Europe. We should be reduced to an unpleasant state indeed if we only had to give up the last imported plant, the potato.

The first importations date from an age long before historic times, and can be determined only from archæological research. The first human inhabitants of Europe, the palæolithic men, had no domestic animals, and depended for their livelihood solely on the natural products of the soil and the fruits of the chase. Centuries after them came the neolithic men, of another race—a pastoral people, bringing with them certain domestic animals. Our knowledge of the kind of life these races lived is only of the vaguest character. But the knowledge of some contemporary tribes who are still living in the stone ages, and without domesticated animals or plants, will enable us to make a fair comparison between the condition of man before their introduction and that to which he has been able to rise by their aid.

The Fuegians and the Australian aborigines are still living in a condition very nearly like that of primitive man. The only habitation of the Fuegians, cold as is the climate of their country, is the hut of branches, their only clothing is the skin of a fox, deer, or guanaco, which they throw over the right shoulder or over the left, according to which is exposed to the wind. They have no domestic animal except the dog, which assists them in hunting, and is of no mean service to them; for their only weapons are a javelin tipped with a sharp bone, and bows, with flint-pointed arrows. They are, in fact, contemporaries of our civilization, still in their palæolithic age. They are not good fishermen. They gather a few shells on the beach, and an occasional stranded whale furnishes them a royal feast. They eat their food with only the slightest preparation, sometimes throwing their meat on the fire for an instant to bring out its salinity. They have no convenient means of making fire, and, if the supply they try to keep goes out, have to resort to the tedious process of rubbing sticks. Their existence becomes most terrible when storms prevent them from hunting and fishing.

The Australians are, if possible, more savage than the Fuegians, but they live in a hospitable country, the natural flora of which furnishes them some food-supply, and the fauna abundant game. But they have no domesticated animal. Their wild dog is sometimes tamed and trained to hunting, but has not been reduced to a really domestic condition. With no habitation or fixed abode, the Australian sleeps wherever night overtakes him. He has no clothing or feeling of modesty. His arms are a wooden lance, tipped with a kangaroo's tooth, and the boomerang. His food depends on the chances of the chase. When it is abundant, he never thinks of saving it; if it is exhausted, he suffers hunger or turns anthropophagist.

The Eskimos of Greenland are also hunters and fishers. Notwithstanding the rigor of their climate, they enjoy conditions of existence infinitely superior to those of the Fuegians and Australians; and they owe their advantages to two animals—one not domesticated, the seal, which nearly supplies all their wants. It being very plentiful on their coasts, they hunt it so regularly as to be nearly always out of the danger of privations. The second animal, the dog, is domesticated, and, besides being a valuable auxiliary in the chase, serves them as a draught animal.

The Eskimos close their windows with seal parchment; they warm and light their huts with seal oil; the basis of their food is seal meat, fish and shell-fish only serving to give variety to it; they wear a full dress of seal-skin sewed with seal tendons, with needles of seal bone; their boots are of seal leather, and their baby-clothes are also made of seal-skin; and that substance constitutes the sheathing to their boats. They are able to travel on land, or snow and ice, in sledges drawn by their dogs. With the conditions of existence thus fairly well assured to them, they have proved themselves accessible to a certain degree of civilization, and have been taught to read and write, and to submit themselves to religious restraints. Yet they are liable to sufferings in seasons of extreme severity which they might escape if, instead of the wild seal, they had some domestic animal on which they could depend for the supply of their food and economical wants.

The reindeer is to the Laplander all that the seal is to the Eskimo, and more. It gives him its skin for clothing, its flesh for food, its horns and bones for tool-making. It furthermore gives milk, and is a pack and draught animal. To these it adds the capital advantage over the seal of being a real domestic animal, so that the Laplander is rarely deprived of necessaries. The dog is also an auxiliary. The Laplander has, therefore, two domestic animals. He has made a corresponding advance in civilization beyond what has been accomplished by the Eskimo.

The Spanish conquerors found two countries in America which had a civilization of ancient date—Peru, where there were two domestic animals, the dog and the llama; and Mexico, which, with no domestic animal but the dog, had an advanced and very productive agriculture. Everywhere else the Spaniards found savages, of whom the Caribs were the most famous. These are represented now by the Galibis and other tribes in Guiana, who exist in a primitive condition, without domestic animals. On his second voyage to America, in 1493, Columbus brought over some European domestic animals, which became the property of the Indians who had intercourse with the whites. The half-breeds of these Indians, the Gauchos and the Araucanians, became in less than two centuries pastoral and agricultural peoples, while other tribes, retiring from the whites, fell into a state of decline.

America, poor in domestic animals and having few cultivated plants at the time of the arrival of the Spaniards, from being able to support only a primitive and sparse population, has by the aid of these elements of civilization become populous and wealthy. The same that has been accomplished in America in three centuries has been done in Australia in fifty years.

From this review of primitive life we draw the conclusions that, wherever he may be found, man is condemned perpetually to a savage and primitive life in a stone age, if he has not command of domestic animals and cultivated plants; from the beginning of human progress comfort of living has borne a relation to the number of domesticated species; and it was by importing their animals and plants, or by acclimatation, that advanced peoples made conquests and colonizations in lands occupied by primitive man. In such cases the natives generally give way before the conquerors.

To the nine animals primarily acclimated in Europe, there were added in the age of the Greeks, by domestication, the goose, bee, and pigeon, and by acclimatation the peacock and the guinea-fowl. In the Roman period the rabbit and duck were domesticated, and the ferret was introduced. After that there were no additions to the domestic fauna till the sixteenth century, when the guinea-pig, American duck, and turkey were acclimated from America. Notwithstanding the small number of acquisitions in this long period, the domestic animals and cultivated plants of Europe were the prime cause of a considerable gradual augmentation in the comfort of the population. They have been brought to a high degree of perfection, corresponding with the growing extent of our wants, and have been subjected to some remarkable modifications, under the new science of zoötechnics; a process of transformation which is still continuous and will never be completed. Species have been divided up to meet the requirements of varied wants, so that one has been made competent to give the service that might be demanded of two, three, and four species. Thus, in horses, we have the riding horse, which can walk, pace, trot, or gallop; the cart horse, which can pull a heavy load at a walk; the stage horse, drawing a lighter load, with a fair degree of speed; and the carriage horse, which travels with speed and elegance of gait. Could the horse have rendered us such a variety of services if he had been left in a wild state? This question is not a gratuitous supposition. The half-wild horses imported a few years ago from the Argentine Republic were of little value, because they had not been fitted, by ancestral training, to perform the various duties required of them.

Instead of increasing the number of species, we have developed varieties within the species, each adapted to a special work. The Laplander has one reindeer, that clothes, feeds, and draws him; we have four or five horses, for the purposes of transportation alone. We have also got animals intermediate between two species.

It is thus found that the material comfort of a people depends much on the animal and vegetable products it possesses, on their variety as well as on their abundance. The variety of animal and vegetable products depends on the number of domestic species and on the number of specialized varieties within the species.

M. I. Geoffroy Saint-Hilaire had shown, at the time of founding the Society of Acclimatation, that most of our animal and vegetable products had come to us through that process as the prime source. While no one could deny the advantages that had been derived from it in the past, some were skeptical as to its utility in the future. But, as M. Quatrefages has said, man is constantly developing new wants; so that the luxury of the evening becomes the necessity of the morrow. He reminds us that the turkey was first imported as a fancier's bird, and the dahlia as an eatable plant; and I. Geoffroy Saint-Hilaire spoke of the guinea-pig, which the experimental physiologist has found so valuable, as useless.

I begin the list of the recent trophies of acclimatation with the great Australian eucalyptus, a few seeds of which planted in 1856, in Provence, produced good trees, showing that the species could be grown on the Mediterranean littoral. It is now at home in Corsica, Algeria, Italy, and Spain, and is distinguished by the properties of rapid growth, making marshy places sanitary, and having a hard wood impregnated with a peculiar essential oil, the presence of which insures its durability. The industrial cultivation of the bamboo was begun in 1861 in the Basses Pyrenées, under the direction of M. Garique. The plantation of four hectares is now very remunerative. Following M. Garique's example, the Southern Railway Company is using the bamboo to fix the taluses of its embankments and adorn its lines. The military administration contemplates using it also on the taluses of its fortifications, where it will have the further advantage of making the works difficult of access. By cutting the stems on a slanting line the ground can be converted into a tract of stiff, sharp stubble that no one will be able to walk over. This has been done in Tonquin.

The *Stachys affinis*, to which M. Pailleux has given the name *crosnes* as a common name, is a labiate plant, allied to sage and mint, and is cultivated in China and Japan for its eatable tubercles. Specimens of it received by the *Société d'Acclimatation* in 1882 were cultivated by M. Pailleux, who finds that the tubercles, cooked about as beans are cooked, have the flavor of the artichoke, and possess the advantage of offering a fresh vegetable in December, January, and February, when such foods are scarce. Thus, in less than ten years, an edible plant has been imported, experimented upon in cultivation, experimented upon in consumption, and definitely acclimated.

The *soja*, a kind of oleaginous pea from China, which, not containing starch, is an excellent food for persons afflicted with diabetes, was introduced in 1855, and has been the subject of numerous experiments by members of the *Société d'Acclimatation*, and has been most extensively cultivated in Austria-Hungary. It has now become a common agricultural plant. The ailantus silk-worm (*Attacus Cynthia*) was imported from China to Italy in 1856, has been largely multiplied, and has now become so well acclimated that it lives in the wild state. It may thus be found living on the ailantus trees in different parts of Paris. It has not yet, however, been made industrially profitable, because its silk is hard to wind, but a means will be found some day of obviating this difficulty.

The first attempts to naturalize the ordinary salmon (*Salmo salar*) in the waters of southern France in 1886 and 1887 were not successful, because the temperature of the water there was not suited to that species. The introduction of the California salmon (*Salmo quinnat*) by the society in 1888 has been attended with a better prospect of success. The stock, obtained from the United States Fish Commission, is prospering, and will probably be the starting-point for peopling the affluents of the Mediterranean with this valuable fish.

The golden pheasant, originally from China, was imported into England toward the middle of the eighteenth century, and has been much in favor as a cage bird. It has lately acquired an economical value from its feathers having come into fashion as an adornment of clothing, and the cages have been called on to supply them. The sacred pheasant, imported from China in 1866, has multiplied rapidly, with a corresponding reduction in price, and it may now be found wild in the chases around Paris, where no more care is taken of it than of other game birds.

The belief that the African elephant can not be tamed is refuted in the case of Juliette, in the *Jardin d'Acclimatation*, who has borne several young, and is distinguished by the two qualities of strength and docility.

Burchell's zebra, or the *dauw*, although it has not yet been naturalized to our farmsteads, has been seen frequently for several years in the streets of Paris serving as a draught animal. These animals make themselves at home in our stables, behave themselves soberly, and reproduce regularly. Eighteen years of experiment in the *Jardin d'Acclimatation* on eight subjects have shown that they are easily tamed, are susceptible of training, and are capable of displaying much strength in draught.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

LAWS OF GOVERNMENT AMONG THE LOWER ANIMALS.

By J. W. SLATER, F. E. S.

"Positive morality under some form or other has existed in every society of which the world has had experience."—(GROTE'S *Fragments on Ethical Subjects*, vol. iii, p. 497.)

WHETHER the author just quoted knowingly or intentionally referred to the societies of the lower animals, as well as to those of mankind, I am not aware. Perhaps, if he had no such intentions, his testimony may be regarded as all the more valuable. Assuredly the ant-hill, the wasp's nest, the rookery, or even the roaming herd of elephants, antelopes, peccaries, or the like, could not cohere, and therefore could not continue to exist as such, without some kind of law and government. Such law, too, must have its foundations laid not exclusively in the physical force of the individual, but in part upon notions of right or wrong, however vague and crude. Absolute personal equality is probably non-existent in any case. Bodily strength plays a part the more prominent the less complex and perfect is the organization of the society. In a herd of bisons, of wild horses, of elephants, or in a troop of baboons, the strongest, generally a male in the prime of life, possesses and exerts a certain supremacy. He holds exactly the same position as does the chief of a savage human tribe; holds it by the same tenure and exercises it in a very similar manner, and subject to the same limitations. That his authority is not absolutely uncontrolled we may learn from a fact to which I shall have to return—the existence of adult males, generally large and powerful, who live in exile.

Among birds the moral life is more highly developed than among mammalia, as we may learn from their being more generally monogamous. Hence, with them, individual superiority sinks very much into the background. The rookery or the heronry seems to form a republic where all are subject to a code of laws which the majority is always ready to put in force against any offender.

The queen bee holds her position by the right of the strongest as against all rivals, and, on the birth or the introduction of another female, she is always bound to do battle to the death for her position. But her sway over her subjects—if such we may consider them—unlike that of the strongest tusker in a herd of elephants, rests nowise upon physical force.

Before speaking of the laws of brutes, we must necessarily first show that they have a perception of duties and of rights. Many facts prove that the lower animals recognize property, and distinguish as clearly as do many men between *meum* and *tuum*. When trespassing they plainly know that their quarrel is not just, and conscience makes cowards of many if not of all.

"You are aware," says a writer in the Zoölogist (vol. v, p. 1635), "that in Rome the inhabitants are accustomed to throw out the garbage and refuse of their houses, which is deposited generally in some blind corner appointed for that purpose by the police. Though several hundreds of these depots exist in Rome, not one is unappropriated, but has become the fee-simple of some particular dog, who will not suffer his claim to be invaded. Some cases of copartnership in a corner have been observed, but with brothers on the death of a parent, and desperate battles occur occasionally about 'fixity of tenure,' as in Tipperary."

The homeless dogs of Constantinople have their particular quarters of the city, into which no dog save its regularly established canine inmates can intrude without the risk of being torn to pieces.

A spider, unless greatly superior in size, hesitates to invade the web of another spider for marauding purposes. Ants consider themselves rightfully entitled not merely to the city they have built, and the roads they have laid out, but to the whole neighboring territory, and they will brave any odds in its defense.

I do not assert that among the lower animals right is the only might. Like the "lords of creation" they often covet what is not their own, and, like them, they sometimes overcome the feeling of respect for their neighbor's landmark. There are feathered and four-footed Romanoffs—*Nachbarfresser*—who, without scruple, seek to absorb whatsoever lies in their vicinity. Nor does righteous indignation always lend the assailed party strength enough to defend his Plevna.

We may go yet further: not only do animals feel a right to such possessions as they have acquired by custom, by first discovery, or by labor. Such right, among social species, is recognized by public opinion, and is enforced by positive law. In support of this statement let us turn to the rookery. It has been observed, not once only but repeatedly, that a particular couple of rooks, too lazy to fetch building materials for themselves, and given to plundering their more industrious neighbors, have been formally punished by the community. The penalty inflicted varies greatly. Sometimes it consists simply in a sound beating. Sometimes the ill-gotten nest is summarily demolished, and the materials are given back to their rightful owners. Sometimes, again—perhaps when sundry former convictions are on record—the offenders, after a severe cuffing, are forever banished from the rookery and left to seek out for themselves a new settlement. On one occasion I saw a rook stealthily approach the bottom of a completed nest and try to remove some of the sticks. But the inmate, reaching over the edge, gave the thief a good peck, whereupon he at once flew away without attempting to defend himself or to retaliate. Similar cases may be witnessed among other species of birds which live in communities.

It may here be pertinently asked whether the laws of the lower animals protect persons as well as property, or whether they resemble the criminal code of England, which imprisons the thief and dismisses the ruffian with a paltry fine—in fact, a retrospective license. In reply, I must point to the "rogue elephants" of India and Ceylon, and to the outlawed buffaloes of South Africa. The gratuitous malignity of these outlaws has been noted by many travelers, and it has been ascribed to their expulsion from the herd. This is confounding cause with effect: they are banished for being quarrelsome and for repeated breaches of the peace.

But to return to the rookery: "crow courts," or crow parliaments" as they are locally called, have been observed in various districts. These are prolonged meetings in which, after much noise, sometimes proceeding from one bird, sometimes from a small number, and then again from the general assembly, a single rook is attacked by the community and put to death. These executions do not seem to be connected with any inroad upon property, since they are not confined to the nesting season, the great time for robberies. There is hence reason to suspect that we have here proceedings for offenses against the person, or against the general well-being of rookdom.

In districts where carrion crows abound, similar trials and executions have also been observed among these bold marauders.

Among rooks, further, laws of a different kind may be traced, the exact purport of which has not been discovered, but which evidently subserve a public purpose rather than the mere regulation of private disputes. For instance, in a grove tenanted by a flourishing rookery, one particular tree, seemingly eligible enough, was never selected for nest-building purposes. If a pair of young birds made the attempt, they were prevented and the foundations of their house regularly removed until they conformed to the custom of their fellow-citizens and built on some authorized tree. In this one case a clew to the proceedings was furnished by accident. A violent storm suddenly overthrew the tree, which, though apparently sound and vigorous, was inwardly decayed beneath the surface of the ground. How the rooks discovered the untrustworthy condition of the tree is a question interesting, indeed, but beside our purpose.

The existence of such laws proves that the rooks have made some advances in civilization, and deem it a duty to protect the lives of their community even against its own ignorance or carelessness. The prohibition of nests in the unsafe tree is a step toward sanitary legislation.

But there are other instances, instructive in their way, where rooks interfere with members of their own community without any apparent cause. White remarks (Selborne, Observations on Various Parts of Nature), "If a pair offer to build on a single tree, the nest is plundered and demolished at once." This has been repeatedly observed by other naturalists where the trees were quite unexceptionable in point of soundness. Surely these birds, by their conduct in such cases, remind us of certain proceedings of our own species. The rooks who persecute their fellow-citizens who build on unauthorized trees are exactly like human beings who claim a vested interest in their neighbors' speculative opinions, who carry scientific questions to be decided upon in a police court, who dictate what may be discussed and what must be ignored, and who seek to limit the methods of scientific research. Hence the rooks are probably the first animals which have evolved the vice of intolerance. Censorships, anti-vivisection agitations, the imprisonment or execution of discoverers, may thus be traced down the zoölogical series, and may be deemed the ultimate transformation of the tabooed trees near the rookery. In the rooks, as in the *demos* of ancient Athens, as G. H. Lewes pointed out, it is curious that the first distinct manifestation of intolerance should be in a republican community. Perhaps here, as elsewhere, political freedom has to be bought at the price of intellectual and moral bondage.

The laws of ants are probably more complete and intricate than those of the rookery. In the ant-hill the individual is completely absorbed in and subjected to the interests of the community. Cases which seem to indicate sanitary legislation have been observed by Sir John Lubbock and others. Theft in communist societies like those of ants can not occur, and needs, therefore, no repression. Neglect of duty does occasionally take place, and it has been seen to be promptly punished with death. Among the agricultural ants of Texas prisoners have been known to be brought in by a fellow-citizen and handed over in a very rough manner to the guards who are always on duty on the level ground before the city, and who carry the offender into the underground passages. Working ants (Mrs. L. Hutton, Journal of the Linnæan Society, vol. v, p. 217) have been seen to be killed by their companions, apparently as the penalty of inaction.

It is sometimes contended that the divisions of the human species in general, or of any of its races and subraces, into nations, tribes, and clans, is a phenomenon which has no parallel among the lower animals. This view is a grave error. Almost every truly and permanently gregarious species, as distinguished from such as merely flock together temporarily for some casual purpose, shows plain marks of a subdivision into nationalities. These tribes, by whatever name man may condescend to call them, possess the main features of similar aggregations among the human species. They lay claim to some particular territory; they defend it to the best of their ability against outsiders, and at the same time in a manner truly human they are not unwilling to encroach upon the domains of their neighbors. They have even two distinct moral codes, one to be observed toward fellow-citizens and the other for aliens of their own species.

Nationality among the lower animals shows itself in two very different types. Among vertebrates, the nation, wherever it exists, is composed, as in the human species, of a number of families, monogamous or polygamous as the case may be.

Among the *Articulata*, at least in the only cases where true nationality can be traced—i. e., among insects—the social unit is not the family but the individual. In the case of the hive bee we might, indeed, say that the family and the nation are coextensive. Among ants this is not the case, since in every well-established ant-hill there are several queens, so that the community is not linked together by blood. It may be contended that the absence of the family, viewed as a something which for most individuals has claims stronger than those of the state, is the cause which has permitted the successful organization of communism in insect societies.

Among ants, bees, wasps, etc., the state has no rival. She absorbs all those sympathies and energies which in human society the average individual devotes to the interests of his wife and children.

We thus see that, from their own point of view, theorists on social reform have been logically consistent in attacking the institution of marriage and the entire system of domestic life, though unwittingly they have sought to approximate man to the condition of the ant and the bee. They would form society, not as heretofore of families, but of individuals; or, as it might be expressed in physical language, they seek to build up the community not of *molecules*, but of *atoms!*

But suppose that communism were successful in the abolition of marriage among mankind, would it therefore reach its ideal? Let us look a little more closely into insect life.

It is not enough to show that the failure of communism among mankind and its success among ants and bees are due to the existence and the power of the family in the former case and to its absence in the latter. We must yet inquire into the why and the wherefore of so important a distinction. Vertebrate society, where it exists at all, is founded on family life, because every normal vertebrate animal is attracted to some individual of the opposite sex by the strongest impulse of its nature, that of self-preservation alone, and not always, being excepted. Invertebrate society where it exists in perfection, as among certain *Hymenoptera,* is not formed of an aggregation of families because the great majority of hymenopterous insects of the social species are neuters, incapable of domestic attachment and devoted to the community alone. To attempt without the existence of neuters to introduce among mankind the social arrangements of the ant-hill is an utterly baseless scheme.

Looking a little further in the same direction, we see that among men there is a wide diversity both in intelligence and in energy. The more highly endowed individual, if he does not leave his children in a better position, materially speaking, is yet likely to hand down to them his own personal superiority. In this manner the equality craved for by theorists is practically annulled.

Among ants nothing parallel can occur. The workers and the fighters are sexless. If any individual is superior to its fellows in strength and intelligence—and certain facts recorded lead us to believe that such must be the case—it has no offspring to whom its gains could be bequeathed or its personal superiority handed down.

Hence the origin of a pariah, a criminal, or a pauper class is prevented. Conversely, the formation of a class *d'élite* is rendered impossible. The ant-hill is, indeed, safe from the existence of the pedagogue and his disciples; but it is, on the other hand, deprived of the thinker, the inventor, and the discoverer.

This is doubtless the reason of the stationary character of the civilization of ants. In proof of this ossification or stagnation, a very interesting fact was pointed out by the eminent Swiss naturalist Oswald Heer. Certain ants belonging to one and the same species are found both in Switzerland and in England. Between the two groups no intercourse can have taken place and no communication can have been transmitted since the "silver streak of sea" was interposed between Dover and Calais—that is, for many thousands of years. Yet on careful examination the social arrangements of these two severed portions, their architecture, and their habits in general, appear identical. Now, had their civilization been undergoing any changes, it is not conceivable that such changes would in both these communities have proceeded at the same rate and taken exactly the same direction. Hence the inference seems plain that in that species of ant progress is at an end.

The brevity of the career of each individual insect acts also decidedly in favor of the preservation of social equality and of the stationariness of civilization. If either ant or man is apt to rise or to fall, then the shorter the time during which such rise or fall is possible the more surely will a uniform level of society be maintained.

To prevent misunderstanding, I must remark that differences of structure, with a corresponding difference of duties, occur among the workers in the ant-hill; but these differences are not transmissible, and the various classes of workers spring indiscriminately from the same parents. Hence they are not analogous to the castes that have arisen in many human races.

It is noteworthy that man has from time to time sought to imitate the neuter order so prevalent in hymenopterous societies. These attempts, however, whether made by devoting certain classes to celibacy, or by a more barbarous method prevalent in antiquity, and surviving in the East even to our own times, have been an utter failure. Celibates have always proved a disturbing force. What would be the effects, moral and social, of the appearance of a neuter form of the human species, corresponding to the working bee or ant, it is difficult to foresee. We may venture to surmise that they would be disastrous.

But, though communists, ants and bees are not cosmopolitans. A stranger of the same species, but belonging to a different nationality, is far from welcome in the hive or the nest. As a rule, death will be its lot.

Wars not infrequently rage between different hives, or between distinct settlements of ants of one and the same species. According to several observers, though the contending armies are to human eyes utterly undistinguishable, yet each individual combatant never fails to discriminate between friend and foe.

Concerning the government of social insects, we are as yet utterly in the dark. We see works undertaken, altered and extended, criminals executed, guards set, food brought in, nuisances removed, expeditions planned, and wars waged, but we do not see the guiding spirit. Who determines in what direction a body of *ecitons* shall set out on a foray? Who regulates the numbers and the position of the guard found at the entrances of an ant-hill? Who relieves the little sentinels in due course?

In some species there are, indeed, large-sized individuals which seem to exercise a kind of authority, but concerning their powers and duties we know little indeed. If the various functions of a human community were left to the spontaneous initiative of all comers, we should have sad confusion. Now, the various duties to be regularly performed in an ant-hill, if less numerous and multiform than those of a civilized human city, yet seem, to our eyes, to be sufficiently complex to necessite a prearranged system.

A most curious fact in ant-life has been observed by the eminent French chemist, M. Berthelot, who is also a zealous entomologist. He noticed in a little wood a flourishing city of ants which for several successive years went on enlarging its structures and laying out roads in every direction. At last, without any manifest cause, it began gradually to decay. It had not been afflicted by wars, nor by scarcity of provisions; yet the number of its inmates seemed to diminish, their energy and activity faded, and their domes and galleries, no longer kept in repair, took a desolate and ruinous aspect. On the other hand, a colony which the old ant-hill had formerly sent out to a considerable distance was becoming the leading city of the district. What might be the cause of this decay of the mother-city is, of course, very doubtful. Perhaps its inmates had had an attack of what is now called "national conscience." Perhaps in a fit of "magnificent self-abnegation"—a modern synonym for suicide—they had decided that it was selfish to look after their own interests, and decreed that such ought to be allowed to perish. Or, it might be merely an instance of the fact that not merely individuals, but communities, races, and species are mortal—the loss of vitality having its wider analogue in the decay of the tribal instinct.

I have formerly witnessed a very similar case among rooks. A huge ash tree, flourishing in the court of a suburban mansion, and known familiarly as the "crow tree," had been, for a term of years going beyond my remembrance, tenanted by a community of rooks to the extent of perhaps twenty-five to thirty nests each season. At last there set in a gradual falling off. From year to year the number of inhabited nests decreased, and those which were unoccupied fell to ruin or were carried off as building materials. When I last had occasion to pass through the town, only two nests remained in the old "crow tree."

All this time a new rookery had been founded in a park at about a mile outside the town, and thither the former denizens of the tree emigrated. This colony is now much more populous than the old settlement had ever been.

The cause of the "decline and fall" is as mysterious as that of M. Berthelot's ant-hill. The birds had not been in any way molested; their ranks had evidently not been thinned by disease, or the new rookery could not have increased so rapidly.

But, whatever might be the causes in these two instances, we see here another feature in common between human nations and the nations of the lower animals.

It has been observed that even common misfortunes will not compel animals of one and the same species, but belonging to different nationalities, to unite. This fact has come under the notice of elephant-hunters. It has sometimes happened that two distinct herds of these animals have been surrounded and entrapped together. In such a case, instead of uniting in one grand charge upon the barriers, they keep coldly aloof from each other.

The penalty of banishment occasionally inflicted upon an evil-doer by a community, whether of elephants, buffaloes, or rooks, involves in its very essence the idea of nationality. Where there is no *patria,* there can be no ex*patria*tion. Any group of beings must feel themselves a community before they could inflict exile upon an offending member.

INTERNATIONAL CONGRESS OF AMERICANISTS.

THE International Congress of Americanists was formed at Nancy, in France, in 1875, for the historical, archæological, ethnographical, and linguistic study of the two Americas. Its subsequent meetings have been held successively at Luxemburg, Copenhagen, Madrid, Turin, Brussels, and Berlin. The last, the eighth meeting, was held in Paris, beginning October 14th. M. de Quatrefages presided, and delivered the opening address, which was published in the Monthly for January. French Americanists were well represented among the participants by Lucien Adam, the Comte de Charency, Remi Simeon, Léon de Rosny, Alphonse Pinart, Desiré Charnay, and Dr. Jourdanet; German, by Schoene, Drs. Hellmann, Joest, Seler, Ehrenreich, Grempler, Herr Künne, and Virchow. M. Fabri, now occupying a cabinet position at home, was missed from the Spanish delegation. Members were present from Holland, Denmark, Italy, Switzerland; Dr. Brinton and Mr. H. A. M. Phillips from the United States; Don Ignacio Altamirano, an Aztec, and Dr. Penafid, from Mexico; Señor Manuel de Peralta, from Costa Rica; and others, not named in Das Ausland's account, from other South American states.

The first question discussed was the one, now of several years' standing, of the origin of the name of America. M. Paul Marcou and M. Lambert de Saint-Bris, it will be remembered, had advanced the hypothesis that, instead of being derived from Amerigo Vespucci, who was also called Alberigo, the name is of native origin, and came really from roots which were also represented in the Ameriqui Mountains of Venezuela, Lake Maracaybo, and the region of Amaracapan in Central America. As against this supposition, M. Jimenez showed that the name of the Ameriqui Mountains did not appear on the oldest maps. Other respondents showed that the name of Ameriqui was not known to the official authorities of Venezuela, and that it is written in a different shape (Amerisque) in documents of very modern date. Testimony was adduced as to Vespucci being called Amerigo as early as 1492 and 1495, in the face of which M. Marcou had been compelled to modify his assertions on that point. Dr. Hamy produced the copy of a map made in Malorca, in 1439, on which was marked in an ancient handwriting the receipt of the cost price in gold from Amerigo Vespucci. The Congress with great unanimity approved an observation by Dr. Hellmann that this question should henceforth be regarded as removed from the programme of its discussions. Dr. Hellmann mentioned a document, printed at Lyons in 1546, in which the compiler purposed to describe briefly America, which is also called L'Ameque, "a group of islands of which little is known." M. Gabriel Marcel, of the Bibliothèque Nationale, called attention to a wooden globe in that institution, called "the green globe," which is supposed to have been made in 1513, and is one of the oldest documents on which the name of America appears. On it the land is shown pierced by a strait passing through the heights of Panama, by which it is divided into two large islands.

M. Gaffarel, of the University of Dijon, gave an account of Portuguese voyages of discovery in the Columbian epoch. The fitting out and leading of these expeditions seem to have been monopolized by the Corte Real family; and claims are made that in 1464, or twenty-eight years before Columbus, Johovaz Corte Real discovered the land of Kabuljane—Canada, or Newfoundland. The first voyage authenticated by documents is that of Gaspard Corte Real, in the year 1500, in which he discovered the *Terra Verdex*—Newfoundland, or Labrador. The next year he undertook a new voyage, with three ships, only one of which came back. The report of these voyages is contained in letters of the Venetian ambassador Pasqualigo, and the merchant Alberto Cantino, to the Duke of Ferrara. It is inferred from them that the expedition reached some region in the far north—perhaps Baffin's Bay, or some neighboring water. Venetian beads have been found used as ornaments by the natives of the coast. In 1502 Miguel Corte Real undertook a new voyage, in search of his brother. He also disappeared. The interest of the Portuguese was afterward turned toward Brazil, discovered by Cabral, which was visited by Amerigo Vespucci in 1503.

The sessions of the second day, under the presidency of Señor Altamirano—who was introduced by M. de Quatrefages as a representative of the pre-Columbian races—was devoted to the archæology of America. Dr. Seler presented the last number of the publications of the Berlin *Museum für Volkerkunde*, containing an interesting chapter of the Aztec original text of P. Sahagun, with pictures and descriptions of thirty-six Mexican divinities, translations, and commentary. He also described the wallpaintings of the palace of Mitla, in red and white, containing many remarkable mythological figures and symbols, which he had copied on the spot, and photographed the pictures.

Desiré Charnay read a long paper on resemblances between the Central American structures and those of eastern Asia, China, and Cambodia, as indicating a derivation of the American race from Asia.

Dr. Seler followed him with remarks on ancient Mexican goldsmith's, lapidary's, and feather work, all of which reached a high condition in that country. We know as yet but little of their methods. The gold was melted up by the Spaniards; most of the feather work—great quantities of which were sent to Europe in the early days of the conquest—has perished by moth-eating, neglect, and dirt. Handicrafts were probably still more extensively carried on in the earlier days of the conquest; but the old chroniclers seldom took pains to give any details on this subject. Exact descriptions can be found only in the Aztec text of P. Sahagun's history. The speaker had copied a large part of two originals in Madrid during the last spring. The ancient Mexican goldsmiths applied gold chiefly—silver only in inlaying—to a kind of linen-lawn fabric. They made cast and hammered ornaments. For casting, a model of the article was carved out of a mixture of fine sun-dried earth and powdered charcoal and covered with a thin wash; or the form was made of clay and coarsely broken coal. Luster was given to the cast object by heating it in an alum bath, and then in a bath of clay mixed with salt. There was a double technic, too, with feather work. In one kind, whole feathers were used. They were stiffened with bamboo and woven together with threads. In this way were many devices fashioned, which the Mexican war chiefs wore strapped to their backs in the dance and in battle. In the other style the feathers were cut up and glued to paper. The feather mosaics, constituting a kind of painting in feathers, were made thus: A ground was formed of the more common, cheaper feathers, and upon it were overlaid brilliant feathers from the *tierra caliente.*

Señor de la Rada y Delgado exhibited a number of ancient Peruvian pieces preserved in the Madrid Museum, that were obtained in the expedition of Ruiz y Paron. He pointed out as particularly characteristic the identity in the form of the utensils of stone and of bronze, and showed a fine bronze axe, which was almost an exact reproduction of the stone hatchet with its string-fastened wooden handle. The handle of this axe is remarkable for its beautiful ornamentation of silver inlayings in the bronze.

The afternoon session of this day was opened by Dr. Brinton with an address in English. M. Eugène Beauvois brought forward for the seventh time his theory, based on the legend of Quetzalcoatl, of a pre-Columbian settlement of America by the Irish. The Marquis de Nadaillac presented the evidence in favor of the population of America in the diluvial period. The Abbé Petitot, long a missionary in British North America, controverted him, affirming that the land was then in the bed of the sea. The Canadian Indians, he said, had a tradition of the world having been overwhelmed by snow. The abbé also told of the creation-myths of the Chiglit Eskimos of the mouth of Mackenzie River, who trace their origin to a giant beaver, living on an island in the western sea. He had two sons. One went eastward to America. From him are derived the Chiglits who wear sticks in their lips. The other went west, to Asia. From him are descended the western Eskimos, called blowers, and, as the Chiglits believe, the Europeans. The island of the tradition was believed to be Bobrovia, or Castor Island, in Bering Sea. The abbé showed a number of utensils of the Mackenzie River tribes and the western Eskimos, which went to confirm, by their resemblance, the tradition of a common origin. M. Raymond Pilet gave some illustrations of the music of the Guatemalan Indians. Not much can be said of their vocal music. For instruments they have a drum and a flute or flageolet, and the *marimba*, which was introduced by the negroes, and can not be called native. Their melodies, as played by the speaker on the piano, had a pleasant sound.

Dr. Deniker gave an account of the results of the French scientific mission to Cape Horn of himself and Dr. Hyades, during which they had spent several years in Tierra del Fuego. They had examined members of three tribes as to their physical peculiarities and differences. Photographs had been brought home of living persons, and prepared specimens of the dead; their dwellings had been photographed, and collections made of their utensils, and the way of using them had been represented as well as possible. These results would all be published in a few months. Dr. Deniker spoke of the voyages, hitherto little known, of Frenchmen to Tierra del Fuego, accounts of which are preserved in the Bibliothèque Nationale. They are those of M. de Beauchesne, about the end of the seventeenth century; of the engineers De Sabat and Du Plessis, who made hydrographic surveys in the Strait of Magellan and along the west coast of South America about the same time; and of the filibuster Jouan de la Guilbaudière, who was shipwrecked in the Strait of Magellan in 1795 and compelled to spend eleven months with the savages. He compiled a vocabulary of more than three hundred words, which is of interest, because it is the earliest collection of Fuegian words we possess. Señor de la Rada y Delgado spoke of the two Maya manuscripts in the Madrid Museum, the Codex Troano and the

Codex Cortes, a paper on the former of which, by Dr. Cyrus Thomas, was noticed in the Monthly for May, 1883. M. Raynaud, Librarian of the Société Américaine, of France, continuing the subject, would distinguish two periods of civilization, one original, generally Mexican, and a later higher, narrower, Yucatecan civilization. Señor Villanova y Piera, Professor of Geology at Madrid, spoke concerning a skeleton which had been found by Señor Carles in the lower deposits of the La Plata region. One of its prominent markings was the evidence of a great wearing away of the teeth by the use of a corn diet.

The fourth day of the Congress was devoted to linguistics; and a number of peculiarities of various languages received free discussion. Remarks were made concerning the geographical name of Central America and the application of the term Anahuac, which Dr. Seler insisted means "the land by the water."

M. Alphonse Pinart submitted two papers on the Antiquities and Rock Inscriptions of the Great and Little Antilles, and the inscriptions on the little island of Aruba, near Curaçoa. The former were ascribed to a pre-Carib population, which the author called the Haytian race. The Aruba inscriptions are very different from those of the Antilles, being cut in the rock, while the others are done in colors. M. Pinart is publishing a series of articles in the Revue d'Ethnographie on the population of the Isthmus of Panama. He distinguishes in Costa Rica the Guetares, civilized inhabitants of the Savannas, living in regular political communities, from the wandering tribes of the eastern forests, the Talamanca Guatusos. The former he regarded as ethnologically identical with the Changuinas of the lagoons of Chiriqui. The same *huacas*, rock inscriptions, etc., are found among both. The Mexicans are a second important element on the Isthmus, and can be found, the author believes, as far down as Chagres and the immediate neighborhood of the line of the canal, and on the Isle of Pearls. But the chief element of the population of the Isthmus, after the Guaymi-Changuinas, is the Cuna, who live on both sides of the territory; a strong, brave nation, fairly well advanced in civilization, living in constant warfare with the Choco Indians, who are in turn under the influence of the highland tribes. They appear to be ethnologically related to the people of eastern Costa Rica. The use of the blow-tube is a peculiar characteristic of the tribes on the Caribbean Sea side of the Isthmus. This paper called out discussion and some dissent.

M. Girard de Rialle read a paper on three treaties concluded in 1666 between the Governor of Canada and representatives of four of the "Five Nations," and the use of totems in the Indian signatures. M. Delisle, of the Museum of Natural History, gave an anatomical dissertation on the deformities of the skulls of the Chinook Indians. M. Marcele Daly exhibited two large water-color drawings taken by his father, many years ago, of plans of the ruined cities of Copan in Honduras, and Utatlan, the ancient capital of the Quichas, accompanying them with remarks on Central American architecture. Among its peculiarities are the presence of walls in the interior of the temple pyramids, and the thorough painting of the whole. The author considered it remarkable, too, that long houses with rows of columns were usually found near the temple pyramids (or *adoratorios*). Dr. Seler exhibited a number of Aztec manuscripts containing plans of the great Temple of Mexico, on which the long pillar houses were likewise seen near the temple pyramid, and remarked that they were the residences of the priests, as is expressly given out in the Sahagun manuscript. As described by M. Théodore Ber, the ruins of the ancient city of Tiahuanaco are composed of a peculiarly colored granite, which probably came from the "Island of the Sun" in Lake Titicaca, and must have been brought to the site on large rafts. Vessels with a capacity for a hundred persons are still in use on the lake. The author explained that the name of the city means "a dried shore," and discussed the probability of the waters of the lake having once reached to the spot. Among other subjects that were considered in papers and discussion were the attributes, relations, and symbolism of the Aztec war-god Huitzilopochli, by Dr. Seler; Ancient Danish Colonies in Greenland, by Prof. Waldemar Schmidt, who held that the eastern and western settlements were not on different sides of the peninsula, but both on the western side; and Vestiges of a Tiahuanaco Civilization, Aztec Cities, and Aztec Potteries in the Pampas, by Señor Moreno, of Buenos Ayres.

Attention was called by M. de Saint-Bris to the assumed Chinese documents relating to a pre-Columbian discovery of America; but their value was disputed by the Sinologue, Prof. Cordier; and Prof. Gafferal explained, with reference to the alleged pre-Columbian discoveries of the Corte Reals, that the name Antilla in Martin Behaim's globe refers to Aristotle's Antilla, and not to an America known before Columbus.—*From Das Ausland.*

M. J. Roche, addressing the International Telegraphic Conference in Paris, recalled some of the objections that were made to the electric telegraph when it first went into practice, as being of historical interest, and as illustrating the extent to which the fear of the new controls the world. Berryer said that the wires running along the railways would cause accidents to the engineers, and with the posts would offer unpleasant sights to travelers; Pouillet said that the expense would be ruinous and without practical results; and that the invention, though an ingenious one, would not displace the old way of telegraphing.

SKETCH OF SAMUEL LATHAM MITCHILL.

THE name and fame of Dr. Samuel L. Mitchill have, in the absence of a complete biography, become to a considerable extent a tradition, known to few except students; yet, during the first quarter of this century, he was one of the most conspicuous figures in the literary and scientific life of the United States. He is called by Dr. J. W. Francis "the Nestor of American science," and "the pioneer philosopher in the promotion of natural science and medicine in America." He was a man of various attainments, and proved himself at home in many fields—in medicine, science, letters, politics, and social life.

Samuel Latham Mitchill was born in Hempstead, Long Island, August 20, 1769, and died in the city of New York, September 7, 1831. He was the third son of Robert Mitchill, an industrious farmer and member of the Society of Friends, and was remarkable for his habits of observation and reflection. His father seems to have taken less interest in his early instruction than his maternal uncle, Dr. Samuel Latham, of North Hempstead, who assisted him to obtain a good classical education. He afterward studied medicine with Dr. Latham; then with Dr. Samuel Bard, of New York; and in 1783 went to complete his studies in the University of Edinburgh, whence he was graduated in 1786. He enjoyed here rare advantages of intellectual society, and had among his contemporaries at the university such illustrious men as Sir James Mackintosh and Thomas Addis Emmet, Dr. Caspar Wistar, Richard S. Kissam, the surgeon; and William Hammersley, afterward a professor in Columbia College. After graduation, and before returning home, he made a pedestrian tour through a part of England. In 1787, after his return to America, he visited Saratoga Springs while it was surrounded by the forest, and ascertained experimentally that the gas extricated from the water was "fixed air, with the power to extinguish flame, destroy the life of breathing animals, etc." He is found in 1788 recording his walking with congenial companions "in the very grand procession for celebrating the adoption of the Constitution of the United States." He began the study of law with the Hon. Robert Yates, Chief Justice of the State of New York, and was shortly afterward appointed one of the commissioners to treat with the Five Nations for the cession of the "Great Western District" to the State of New York. He attended the council at Fort Stanwix, witnessed the deed, and received names from the Oneidas and Onondagas.

In 1790 Dr. Mitchill was chosen a representative from Queens County in the New York Legislature. In the next year he exerted himself to form the North Hempstead Library Association and Library. In 1792 he was appointed Professor of Chemistry, Natural History, and Philosophy in Columbia College, where, while dissenting from some of the principles of the French chemist, he introduced, for the first time in the United States, the chemical nomenclature devised by Lavoisier. His dissent from Lavoisier led to a controversy with Dr. Priestley, at the end of which the two disputants found themselves on a footing of mutual esteem and warm personal friendship. He records himself in 1794 as having exhibited at full length, in a printed essay, the actual state of learning in Columbia College. At about this time, too, he was co-operating with Chancellor Livingston and Simeon De Witt in the establishment of the Society for the Promotion of Agriculture, Manufactures, and the Useful Arts, before which he delivered his first public address. Having executed a commission from this society for that work, he made a detailed report, in 1796, of geological and mineralogical observations on the banks of the Hudson, for coal, etc.—a performance which, he mentions, was respectfully quoted by Count Volney. This was the first work of the kind undertaken in the United States, and the report helped to secure a wide European as well as American reputation for the author. Referring to it, Dr. J. W. Francis says, "He may fairly be pronounced the pioneer investigator of geological science among us, preceding McClure by several years." The report was published in the Medical Repository, a quarterly magazine begun in 1797 by Dr. Mitchill, with Drs. Edward Miller and Elihu H. Smith, and continued by Dr. Mitchill for more than sixteen years.

After his marriage, in 1799, to Mrs. Catharine Cock, which brought him the enjoyment of an ample fortune, Dr. Mitchill was able to devote himself entirely to scientific and public occupations. Among the scientific works with which he accredits himself during the few years succeeding this event is the publication of a chart of chemical nomenclature, with an explanatory memoir, in which he contended that metals in their malleable and ductile state are compounds of a base with hydrogen (phlogiston), as in their calciform state they consist of a base with oxygen; and that in several there is an intermediate condition in which there is no union either with hydrogen or oxygen. And he extended the same doctrine to the greater part of inflammable bodies. In 1802 he records a correspondence with Albert Gallatin, Secretary of the Treasury, on a project for illuminating the lighthouses of the United States with inflammable air. In 1806 he wrote the introduction to the American edition of Assalini's Observations on the Plague, Dysentery, and Ophthalmy of Egypt; and in the ensuing winter translated from the Latin Lancisi's book on the noxious exhalations of marshes at Washington—a work which was afterward printed in the Medical Repository. As a member of the Legislature, he supported, in the face of ridicule and opposition, the act of 1798 giving Livingston and Fulton the exclusive right to navigate the waters of New York by steam. He performed, with Fulton, in August, 1807, the first voyage in a steamboat. He was again chosen to the Assembly in 1797 as one of the representatives from the city and county of New York for a term of service which he marked as distinguished by his introduction of a motion relative to the sixth commandment, requiring citizens to labor on the six days as well as to refrain from labor on the seventh day. In 1801 he was elected to the national House of Representatives, as member from the district consisting of the counties of Kings and Richmond and the city and county of New York. He was appointed to the Senate in 1804, to fill the vacancy caused by the resignation of John Armstrong, and after the expiration of his term there, in 1809, served in the House again till 1813. A bright picture of his life in Washington is given in the letters written by him to his wife during his term of service, a selection from which was published in Harper's Magazine in 1879. They are full of the life of the politics and the society of the capital, and the telling of the incidents is made more attractive by the writer's always lively humor.

The lines of Dr. Mitchill's work in Congress are indicated by various notes in his letters and in the record which he has left of Memorable Events and Occurrences in his life. During his first term he was a member of committees of the House on Commerce and Manufactures, the Naturalization Laws, the protection of American seamen and commerce against the Tripolitan corsairs, Naval Affairs, memorials concerning perpetual motion, Patent Rights, the Mint, and French spoliations. He labored in the Senate for the adoption of improved quarantine laws, "and was strenuous," says Dr. Francis, "to lessen the duty on the importation of rags, in order to render the manufacture of paper cheaper, the better to aid the diffusion of knowledge by printing." In December, 1811, he brought up for adoption by the House of Representatives a report favorable to the "nascent nations" of Spanish America, and "full of good wishes toward them in their exertions to become free and independent." In connection with the War of 1812 he acted as a commissioner under the Navy Department in constructing a floating battery or heavy vessel of war, to defend the sea-coast and harbors of the United States; and in 1814 he was found laboring jointly with his patriotic neighbors, "with mattock and shovel, in the trenches for several days, to erect fortifications against the enemy."

National and social matters did not absorb Dr. Mitchill's attention in Washington to the exclusion of his interest in scientific inquiries. Curious speculations and remarks appear in his letters about phenomena which came under his observation. In one letter, Dr. Mitchill wishes his wife to inform him exactly at what hour a certain storm began. "I wish to know," he said, "exactly when the storm began in New York, as it is connected with other facts tending to a theory of the atmospheric motions in winter." Another letter, forwarding a specimen of the *Mitchella repens*, explains why no plant had been named after him. Prof. Willdenow, of Berlin, had intended to give his name to some plant, but found it already appropriated by this partridge-berry, which was named by Linnæus in honor of John Mitchell, of Virginia. He was more fortunate, according to Dr. Francis, in the matter of fish. "He was the delight," says this biographer, "of a meeting of naturalists. The seed he sowed gave origin and growth to a mighty crop of those disciples of natural science. He was emphatically our great living ichthyologist. The fishermen and fish-mongers were perpetually bringing him new specimens. They adopted his name for our excellent fish, the striped bass, and designated it the *Perca Mitchilli*."

He writes concerning a conversation he had with Captain Lewis, the explorer, about the burning plains up the Missouri, where the burning strata of coal underlying the plains produced such intense heat as to form lava, slag, and pumice-stone by the same process that forms those volcanic substances in the burning mountains of other countries. December 30, 1807, he congratulates his wife on the account in one of her letters of the meteoric stones that fell to the earth in Connecticut, which arrived at a most convenient time, having preceded all the letters to the Connecticut delegation, and even outrun the newspapers. Dr. Mitchill also during this period visited Upper Canada, and described the mineralogy of Niagara Falls; wrote a history of West Point and the Military Academy; and visited Harper's Ferry and described the geology and scenery of that spot, which had been eulogized for its sublimity by Jefferson in his Notes on Virginia. Dr. Mitchill retired from his professorship in Columbia College on his election to Congress, in 1801. In 1807, when the College of Physicians and Surgeons of the City of New York was organized, he was chosen its first Professor of Chemistry, but declined the position, preferring his public duties. In 1808, however, he accepted a professorship of Natural History; and in 1820, on the reorganization of the faculty, became Professor of Botany and Materia Medica. Difficulties occurred with the Board of Trustees in 1828, and the whole faculty of the college resigned. Among other works for the advancement of science and learning mentioned in his record are his action with Drs. Hosack and Hugh Williamson in laying the foundation of a Literary and Philosophical Society in New York, in 1815; the reading to the society of a narrative of the earthquakes of the United States and in foreign parts, during 1811, 1812, and 1813; co-operation in a petition to the Common Council of New York for the grant of the building in the North Park for the purposes of Literature, Science, and Arts; the delivery, in connection with a curious case by which the town was stirred, of a public lecture on the Somnium, or dream, as a state different both from wakefulness and sleep; an excursion with friends to the region watered by the Wallkill, where the party disinterred a mammoth; participation in an excursion to the Neversink Hills, near Sandy Hook, where a dangerous mistake in their altitude, which had been supposed to be six hundred feet, was corrected, and the real height was found to be only half as great, or three hundred feet; acting as vice-president of the District Convention which met at Philadelphia for preparing a National Pharmacopœia; and co-operation with Samuel Wood and Garrett K. Lawrence in recommending the willow-leaved meadow-sweet (*Spiræa salicifolia*) "as an admirable article for refreshment and health, and as a substitute for the tea of China." A description and classification of one hundred and sixty-six species of fish, chiefly found in the fresh and salt waters adjacent to the city of New York, which he offered to the Literary and Philosophical Society at one of its earlier meetings, was the nucleus of what is regarded as his chief work. He mentions in his record more than forty additional species described in Bigelow and Holly's Magazine, and several more in the Journal of the Philadelphia Academy of Sciences. An elaborate History by him of the Botanical Writers of America is to be found in the collections of the New York Historical Society. Of his literary and scientific work as a whole, in fact, it is well said in the Cyclopædia of American Literature that numerous papers by him are included in the Transactions of the many learned societies of Europe and America of which he was a member; and he was often called upon, at the anniversaries of the societies of his own city, to appear as their orator. "His multifarious productions are consequently scattered over a number of publications and collections of pamphlets, and are somewhat overshadowed by the reputation of the learned bodies with which they are connected. They have fallen, to some extent, into an unmerited oblivion." He had committed his manuscripts to his brother-in-law, the late Dr. Samuel Akerly, as the friend most competent to write his biography, and the work was begun, when the papers were destroyed by the burning of the house in which they were deposited. Had Dr. Akerly not been thus prevented from completing this work, and had he been able to present Dr. Mitchill's life and writings in substantial form, the subject of our sketch would doubtless have received the credit to which he was entitled, and have been made to appear as one of the most vigorous leaders of early American science.

The scientific items in Dr. Mitchill's record are continued with mention of the introductory lecture to the College of Physicians, etc., on the life and writings of their late president, Samuel Bard, 1821; a philosophical discourse in St. Stephen's Chapel, Bowery, to the class formed in that congregation for cultivating the natural and physical sciences, 1822; a discourse on the Life and Writings of Linnæus, at Prince's Botanical Gardens, Flushing, on the anniversary of the Swede's birthday in 1823; and the publication of a catalogue of the geological articles and organic remains which he presented to the museum of the Lyceum. In 1823 he appears as performing, after the Venetian example, on an invitation from Albany and a mission from New York, the ceremony of marrying the Lakes to the Ocean, at Albany, "on the day of the unprecedented gathering of the people to witness the scene of connecting the Western and Northern Canals with the Hudson"; and again, two years afterward, as a member of a committee for celebrating the completion of the Western Canal, when, in the vicinity of Sandy Hook, he pronounced an address "on the introduction of the Lady of the Lake to the estate of her spouse the Lord of the Ocean." This, according to Dr. Francis, was the proudest day of his life. He also acted on a committee, in 1824, to receive funds in aid of the efforts of the Greeks to achieve their independence.

Dr. Francis says, summing up his work, and quoting at least a part of the estimate from the book, Old New York, that "the universal praise which Dr. Mitchill enjoyed in almost every part of the globe where science is cultivated, during a long life, is demonstrative that his merits were of a high order. . . . His knowledge was diversified and extensive, if not profound. His first scientific paper was an essay on Evaporation. His mineralogical survey of New York, in 1797, gave Volney many hints; his analysis of the Saratoga waters enhanced the importance of those mineral springs. . . . His ingenious theory of the doctrine of septon and septic acid gave origin to many papers and impulse to Sir Humphry Davy's vast discoveries; his doctrines on pestilence awakened inquiry from every class of observers throughout the Union; his expositions of a theory of the earth and solar system captivated minds of the highest qualities. His speculations on the phosphorescence of the waters of the ocean, on the fecundity of fish, on the decortication of fruit trees, on the anatomy and physiology of the shark, swelled the mystery of his diversified knowledge. . . . His researches on the ethnological characteristics of the red men of America betrayed the benevolence of his nature and his generous spirit. . . . He increased our knowledge of the vegetable materia medica of the United States, and wrote largely on the subject. . . . He largely seconded the views of Judge Peters on gypsum as a fertilizer. . . . His letters to Tilloch, of London, on the progress of his mind in the investigation of septic acid—oxygenated azote—is curious as a physiological document. . . . He was associated with Griscom, Eddy, Colden, Gerard, and Wood in the establishment of the Institution for the Deaf and Dumb; and, with Eddy and Hosack, may be classed with the first in this city, in respect to time, who held converse with the afflicted mute by means of signs."

It would be difficult, says an article in Harper's Magazine for April, 1879, for those who never saw Dr. Mitchill, "to conceive the deference paid to his learning and judgment. His knowledge of the physical sciences, his varied and intimate acquaintance with classical literature, both ancient and modern, his attainments in history and political science, his practical acquaintance with public affairs, and his remarkable affinity with the common and useful arts, caused him to be looked upon as a fountain of learning always ready to pour forth abundant streams of knowledge to every thirsty applicant. A witty friend once said of him, 'Tap the doctor at any time, he will flow.' Accordingly, the merits of all inventions, discoveries, projects, arts, sciences, literary subjects and schemes, new books and publications, professional cases, acts of charity or public spirit, and a multitude of other things, used to be submitted to his critical opinion. If he had not been one of the most polite and amiable of men, he could hardly have borne the demands thus made upon his time and patience." Dr. Francis relates that, being present at his funeral, he stayed till all but the sexton had gone, and then asked, unrecognized by him, whom he had just buried. "A great character," the man answered, "one who knew all things on the earth and in the waters of the great deep." Dr. Francis is also authority for the story that when the purchase of the Elgin Botanic Garden by the constituted authorities was argued at the Capitol, "he won the attention of the members by a speech of several hours' length, in which he gave a history of gardens and the necessity for them. . . . With his botanical Latinity occasionally interspersed, he probably appeared more learned than ever. Van Horne, a western member, was dumfounded at the Linnæan phraseology, and declared such knowledge to be too deep for human powers to fathom."

As described by Dr. Francis, Dr. Mitchill's appearance before his class in the instruction-room was that of an earnest instructor, ready to impart the stores of his accumulated wisdom for the benefit of his pupils, while his oral disquisitions were perpetually enlivened with novel and ingenious observations. Chemistry, which first engaged his capacious mind, was rendered the more captivating by his endeavors to improve the nomenclature of the French *savants*, and to render the science subservient to the useful purposes of agriculture, art, and hygiene. In treating of the materia medica he delighted to dwell on the riches of our native products for the art of healing, and he sustained an enormous correspondence throughout the land, in order to add to his own practical observations the experience of the competent, the better to prefer the claims of our indigenous products.

Many of Dr. Mitchill's scientific papers were published in the London Philosophical Magazine, New York Medical Repository, American Medical and Philosophical Register, New York Medical and Physical Journal, American Mineralogical Journal, and Transactions of the Philosophical Society of Philadelphia; and he supplied several other periodicals, both abroad and at home, with the results of his cogitations.

Dr. Mitchill was the author of a few verses, and of prose essays or addresses of an order of humorous trifling, much affected at the time, of which the lighter works of Irving and Paulding furnish the most conspicuous examples, and with which Halleck's verses are in sympathy. One of his favorite topics was a proposition to give a new name—Fredon, or Fredonia—to the United States, after which the people should be called Fredes or Fredonians, and their relations Fredish or Fredonian. The subject was taken up and discussed in the New York Historical Society, but has long since been forgotten.

His social and domestic character, according to the writer in Harper's Magazine, was unusually amiable and attractive, and marked by many amusing peculiarities. He had great fondness for young people, and a rare power of inspiring them with the love of knowledge. His home was pleasant and unpretending, "and the numerous celebrities who used to resort to his *salon* were entertained with cordial but simple hospitality." His house was a perfect museum of curiosities, and Mrs. Mitchill used to be troubled by the disorder they occasioned. As pertinent to this nuisance, the story of the ant-eater's skin was told. At first the skin was an object of great interest. Then it became dingy and dusty, and was remanded to the garret. In two or three years more it became old and moth-eaten, and Mrs. Mitchill and the servant, not wishing to worry the doctor, had it secretly carried off and thrown into the street. Dr. Mitchill, taking his regular walk the next morning, came upon a group of boys curiously looking at some unusual object, which proved to be the ant-eater's skin. He joined them, and, after giving them a full scientific lecture on the ant-eater, said he had a skin like this one at home and would be glad to have another—and bought it from them for fifty cents. No further attempts were made to get rid of it.

CORRESPONDENCE.

A DEFENSE OF THE ARCHITECTS.

Editor Popular Science Monthly:

SIR: Mr. Barr Ferree's articles on modern architecture, in the June and December numbers of the Monthly, are interesting as giving an outside view of the present condition of that profession; but the writer fails to discriminate between past performance and present tendency, between evils in the ascendency and evils on the decline. He appears, indeed, quite uninformed as to what is being done by our leading architects and as to the spirit and methods of their work, and judges the architecture of our time by its worst instead of its best performances. The views he expresses are more or less widely prevalent in the community, and now that they have found such pointed and vigorous utterance, demand that some one should call attention to the fallacy of a part, at least, of their assertions. Architects are not such unwilling listeners to lay criticism as this writer would have us believe, but they do ask that it shall justify itself by clear definitions, precise statements, and evidence of thorough acquaintance with the various bearings of the subject. These are to be looked for in vain in the above-mentioned articles, which, moreover, seem to ignore the progress made by the profession in the last twenty years (in house-planning, for instance, in which the work of our architects has aroused wide-spread interest even among the conservative French). Both articles attribute to architects as a class a disregard of sanitary and mechanical requirements quite unwarranted by the facts, and deprecate the attention they pay to exterior design, although most critics find this the weakest side of their work. They are written in apparent ignorance of the fact that it is to the architects that we owe in great measure our municipal building laws and a large part of the modern advance in scientific construction and in sanitation applied to building. The strictures in these papers appear to be based on reading rather than on careful observation. Their author follows hard after Ruskin in his apparent hatred of the Renaissance, and the last part of the Fifth Discourse in Viollet-Leduc's Entretiens sur l'Architecture would seem to have furnished a large part of the ammunition for his December assault; but the Entretiens were written seven-and-twenty years ago, and the evils at which they were aimed, however prevalent in France at the time, and however characteristic even of our own architecture twenty years ago, are not fairly characteristic of it now. The article in question is out of date; it is a quarter of a century behind the times.

It is practicable here to notice only in a summary way the erroneousness of its main contentions. The grain of truth in them need not be denied. That there are charlatans and ignoramuses among the architects of our day is as true as it is of the legal, medical, or clerical profession, or of any other class of men following a common pursuit. It may even be admitted that among them are to be found not a few men of intelligence and culture who are pursuing their career along mistaken lines or without sufficient technical training; but from this to the denial of the existence of intelligence or conscience in the profession is a long distance across which one should not attempt to leap without looking. Is it indeed true that charlatanry and ignorance control the profession and give it its character? Is it true that architects generally subordinate common sense to caprice? Is it true that when a client comes with a rational, well-considered, and practical programme for a given building, the architect generally disregards his wishes and fools him out of his programme by pretty pictures intended only to catch his eye and a commission, or that in the average work of representative architects the demands of exterior ornamentation alone dictate the interior planning? Is it true that our architects have signally failed to avail themselves of modern progress in scientific construction? Is it not rather true that they have, on the contrary, often been the pioneers in the introduction and development of new materials, appliances, and building processes? It is certainly a mistake to assert that Roman architecture paid no attention to exterior effect, and did not largely avail itself of the splendor of internal adornment by applied ornament. It *was* subject to the changes of "fashion," and its forms are largely the product of a change of fashion following the conquest of the Greek world. The like is true of many phases of Gothic and other historic styles.

The contentions of the articles under consideration need only to be stated in the plain and concise form of these queries and denials to appear to every well-informed and fair-minded student of our architecture an almost grotesque caricature of the true state of affairs. Their effect, in view of the reputation of the magazine through which they have been given to the public, can only be to foster existing prejudices, however vague and unfounded, against architects as a class, and to impede instead of helping on the reform of our architecture. It is hardly too much to ask that writers on the state of modern architecture will, before pronouncing absolute condemnation, make the acquaintance of our leading architects, visit their offices, study their methods, familiarize themselves with the great difficulties and amazing complications of the architectural problem, and carefully examine the efforts which these men are making for its satisfactory solution.

Yours, etc., A. D. F. Hamlin,
Adjunct Professor of Architecture,
School of Mines, Columbia College.

New York, *December* 17, 1890.

NEW ENGLAND AGRICULTURE.

Editor Popular Science Monthly:

Sir: I have just been reading Prof. Currier's article on The Decline of Rural New England. It does not in any degree satisfy me as an exposition of things as they are. Like him, I was born close to the soil; like him, I have been and am a student; but, unlike him, I am now, and have been for most of my life, a practical farmer. My diagnosis of the case is (consequently) quite different. I agree with him only in thinking that our tariff laws have generally done the farmer more harm than good. He utterly ignores the chief of all the reasons why farming has declined, so far as a decline can be noted. This decline is in the hill-farms chiefly, and it has been coincident with the opening up of Western free lands. But it has also been coincident with a great decline in the fertility of those farms, with no corresponding increase among the farmers of knowledge how to prevent such decline, or how to restore lost fertility.

The comfort and prosperity of the earlier generations of our farmers are exaggerated. There was as much debt, as little general advance, and very much more vice among New England farmers fifty years ago than now. Prof. Currier makes the common mistake of comparing the valley farmers of fifty years ago with the hill farmers of the present day. By the enforcement of prohibitory laws, and the general reprobation of intemperance in the rural districts of New England, the moral condition of the hill farmers has been, on the whole, much improved, and their manner of life—their civilization—much advanced. But, in the mean time, for lack of instruction, their lands have become infertile to the degree that they fail to give them a good living; while free farms in the West have been made so cheaply accessible to them that they have sold out and gone away. This is the whole explanation of what has been and is called the "decline of New England farming." The census does not reveal any real decline. The value of the agricultural products of New England is still as large, per acre and per man; while compared with other sections New England yet stands with the best States, even without allowance for the natural inferiority of much of her soil. "Plenty of food, plenty of children." As the fertility of the hill-farms disappeared, so came the decline in the size of the families on them. Is this only a coincidence? I think not; although I admit an equal decline elsewhere, from different causes.

If religion has declined among our people, there has been no accompanying decline of morality. The ministers have lost much of their influence, chiefly because they have been educated away from the people. In my youth the rural ministers were among the best farmers we had. Now, I do not know in a whole county a minister who takes any interest in agriculture. A farming ministry would be a great help to New England agriculture, and equally to moral social life. But our classical schools and colleges all educate away from the farm and from sympathy with the plain people. Our rural ministers are almost to a man the outspoken foes of science, as being destructive to the dogmas upon which their religious systems are built.

The hill-farms in New England are "played out." Many of them are going back to forest, which is perhaps their best use. But one has only to take a carriage trip through our river valleys to see abundant signs of agricultural progress and prosperity. Not that even our valley farmers have not their "ups and downs"—their years of bad as well as of good times—but they and their families live better, have more, and enjoy more, much more, than did their fathers and grandfathers. They are better educated; and many of them, and of their families, are careful readers and students of their art, as well as interested in the general progress of the world. Their great need is for better schools, in which scientific instruction should have the first place. The old literary methods, though still supported by the college and seminary bred clergy, are obsolete, useless, and prejudicial to the advance of true civilization and the industrial arts, especially the art of agriculture. T. H. Hoskins.

Newport, Vt., *January* 10, 1891.

EVOLUTIONARY ETHICS.

Editor Popular Science Monthly:

Sir: Some of the difficulties that trouble your correspondent K——, in regard to evolutionary ethics, will, I think, disappear by enlarging his conception of happiness so as to include the happiness of society as well as that of the individual. In the long run, and in the main, these two coincide; but it is evident that with our present imperfect moral development there must arise many instances where the welfare of society runs counter to the happiness of the individual. All this is involved in what Mr. Spencer teaches in his Data of Ethics; but perhaps it may be made plainer if we substitute for happiness the more comprehensive word adaptation. Perfect adaptation —that is, the complete and continuous adjustment of internal relations to external relations — would be complete happiness were it attainable, as it covers both the physical and psychical sides of our nature. It includes perfect bodily health as well as perfect mental and moral health, and does not oblige those who teach scientific ethics to face the "disagreeable conclusion" mentioned by your correspondent. In fact, the substitution of adaptation for happiness as the criterion of morals has several advantages.

It bases morality upon the principles of evolution. The development of society implies the development of certain moral instincts in the individuals who compose it; for it is apparent that, unless selfishness is more or less restrained by altruism, social growth would be retarded if not stopped. It explains why opinion varies both in time and place in regard to conduct, for actions are considered virtuous by a given society when they are regarded as conducive to its welfare and sinful when they are supposed to be injurious. It accounts for the gains which altruistic sentiments have made upon egoistic, in man's progress upward, as social contact creates and fosters a public opinion in favor of the former, which is slowly becoming more and more irresistible, until finally shall dawn the era of peace upon earth and good-will to men.

Robert Mathews.

Rochester, N. Y., *January* 4, 1891.

EDITOR'S TABLE.

A PROFESSION FOR WOMEN.

THE crusade for the higher education of women that is now going on seems to have two chief impelling forces. One is the necessity for a growing number of the sex to provide for their own support; the second is the weariness of being idle that is afflicting another class of women. It is not necessary to point out here the reasons why women without male supporters are more numerous than formerly. They are mainly such as cause the deferment or abandonment of marriage by many men and women, through making family life less attractive and single life more satisfactory to both sexes. The same reasons, with others, operate to increase the number of wealthy women who have nothing to occupy them.

As a remedy for both these ills, collegiate education is being widely prescribed. This promises admission to lucrative professions to the bright women who must support themselves, and offers the degree of a men's college as the goal of their wealthy sisters' efforts. These remarks have been suggested by a recent volume in the International Education Series, on Higher Education of Women in Europe, by Helene Lange, which advocates the collegiate education idea, though in a notably reasonable and discriminating manner. But this way of treating the difficulty has serious defects. In the first place, it tends to increase the evil which it is expected to cure. The lack or deferment of suitable marriage is what is at the bottom of the whole matter, and the literary and professional education of women would make this lack greater. Independence of a husband's support would favor maiden life (though to the extent of preventing false marriage this is a good thing); so, too, would the absorption of women's interest and ambition in study or in a professional career. Moreover, women who have been occupied with books or business to the exclusion of learning how to make a home will not be very desirable as wives. Secondly, the proposed remedy would stimulate that undesirable trait, selfishness. It puts before a young woman the ideal of learning a profession for the benefit of *self*, of winning honors for *self*, of acquiring a high culture for *self*. It crowds out the opposite idea of fitting herself to co-operate with a husband for their joint benefit and that of their children, or the idea of using her leisure for the elevation of the race. Furthermore, anything that teaches men and women to live independently of each other lessens the respect that belongs to the family as an institution, and robs parenthood of the honor that it deserves.

Before reading thus far, our critics will be demanding what alternative remedy we have to offer for the ills whose existence we admitted at the outset. We would strike at the root of the difficulty, and remove the disturbing cause instead of accepting it as inevitable. Earlier and more numerous marriages should be the rule, and women can bring this about if they choose. Mothers should so rear their daughters that young men can afford to marry them. A young woman properly brought up would be healthy and strong enough to need few or no servants and little doctoring; she would be competent to manage a household; and would not have a fondness for extravagance that is like a second nature. Women should discountenance the men who remain bachelors without good reason, and especially should shut out of good society those dissipated youths and wealthy rakes who are the deadliest enemies of the marriage relation. By these and similar means women can secure for most of their sex the most natural mode of support—that which belongs to a wife. For those women who do not lack means, but only an object on which to employ their energies, there is worthier occupation than acquiring culture for its own or rather their own sake. There are social and ethical questions, and other problems, whose solutions are demanded, and which can be best solved by women. There are affairs to be administered and abuses to be corrected for which woman's nature especially fits her; and there are other fields of labor, not hers exclusively, but which are imperfectly worked because left to man alone. As a shining example of women who have already seized upon such a chance for usefulness may be mentioned the Ladies' Health Protective Association in New York city, which is engaged in abating nuisances prejudicial to the public health. There might remain some women who could not be provided for in the ways just suggested, but they would be exceptions, and their wants could properly be met by exceptional methods.

There is a class of women to whom the counsel in this article will be very distasteful. The career of a wife and mother has little appreciation in their eyes. It is not enough appreciated by a large share of both sexes. But the remedy for this is in the women's own hands. If they would have an honorable profession, they have only to do a quality of work that is worthy of honor. Surgery was once a branch of the barber's trade, and certainly no more honored than house-work is to-day; but men have made a study of it, have given it a broad, scientific basis, invented instruments and processes to increase its efficiency, and arranged a systematic mode of learning its practice, with the result that the surgeon of to-day has one of the most honorable of professions. In a similar way dressmaking—which is a trade in the hands of women—has been made a profession in the hands of one man. The ordinary dressmaker gets little respect; Mr. Worth is held in high esteem, and the difference is that he does work which compels esteem. The ordinary housewife and mother takes little pains to learn her business; she follows rule-of-thumb methods handed down from her great-grandmother, introducing no improved processes or appliances, and feeling no shame if her home is ill managed or her children ill trained. If women doubt that competent administration in the home would win the same esteem that is paid to the competent surgeon, or lawyer, or merchant, or college professor, they should recall the Roman matron, Cornelia, whose fame has already lasted for nearly a score of centuries. With her spirit the modern woman should say of her home, "This is my diploma"; and of her children, "These are my degrees."

SCIENCE AND CIVILIZATION.

THAT civilizations have perished in the past is a commonplace of historical reflection. That all is not well in the latest of civilizations is a truth which earnest men are feeling more deeply from day to day. Undoubtedly there are influences at work that tend to antagonize the true evolution of society. There probably never was a time when so many people felt themselves unsuited to their environment, when there was so much of unsatisfied ambition or so much unsettlement of purpose. We have disengaged forces that sometimes threaten to be too strong for us. We have created in thousands of minds expectations which even the improved conditions of modern life are unable to satisfy. Men have been taught that two giants of unexampled strength are ready to do their bidding, one called *Science* and the other *Legislation*: with these the world is to be renovated. That there can be little renovation apart from renovation of individual character is a truth which, whether believed in or not, has been kept in the background. The discussion that has taken place regarding "General" Booth's scheme for the extinction of pauperism and degradation in London has made it clear that certain guiding principles of social reformation are seriously needed, and that, unless these are found and acted upon, our whole social system may suffer grievous injury.

The key-note, the watch-word of social reform, some say, is to be found in *charity*—that is to say, in the benevolent interest of man in his fellow-man. These would organize moral salvage corps, would visit the poor and degraded and try to heal and restore them by kind words, good advice, and pecuniary or other equivalent assistance. That, under favorable circumstances, something can be accomplished in this way we should be extremely sorry to deny. Many a man doubtless needs no more than some slight, kindly intervention to enable him to recover a wavering balance and betake himself with fresh courage to the battle of life; but whether wide-spread social diseases are to be successfully coped with by charity in any of its forms is still a question. Charity is the word of Religion, and a beautiful word it is, expressing fundamentally a beautiful idea; but it is not the word of Science: the word of Science is Justice. Are, then, charity and justice incompatible? Far from it; there is a charity that is just—that is no more and no less than justice—and there is a justice that is charitable in the highest sense. We shall attack our social problems successfully only when, leaving all sentiment and all unproved assumptions aside, we seriously ask ourselves as a community what we ought to do, what justice requires us to do. If justice demands what might be called charity, let us not call it charity or disguise it under any other specious name, but let us call it justice and nothing else. If it is pleasant to get good in the form and name of charity, far sweeter and far more strengthening and every way beneficial is it to get it in the form and name of justice. It is a misfortune that the word justice has been so often associated with the penal administration of the law, and that in this way it wears a severer aspect than properly belongs to it. The law should be a terror to evil-doers and to none else; and we should accustom ourselves to think of justice as the most beneficent of divinities and the very palladium of our civilization. This it is, whether we so recognize it or not; only as we are in the main a nation of just men is our civilization secure.

To follow out in detail the applications of the principle of justice to our social miseries and weaknesses is beyond our present purpose. So much, indeed, do people in general think of charity as a social remedy, and so little do they think of justice in that light, that it would not be surprising, were a change of policy from charity to justice decided on, if there should be a marked unreadiness and inaptitude for the practice of the new virtue. It might be found, moreover, to involve a great deal more than charity had ever appeared to involve. When a man is bestowing charity he may give little or much; as it is all a free gift, there is virtue, there is merit, there is room for self-commendation, however little he gives; but when he is dealing out justice the case is different: he must go to a certain line or *he fails in justice* and is open to condemnation. No wonder charity is the favorite virtue; but the more we compare the two the more we see that justice is the better for the soul. It does not flatter self-love, and it is more favorable to respect for our fellows.

Justice, we have said, is the word of science, and herein we see where science may powerfully help to strengthen the social fabric. On the one hand, science tends to produce social ferment by continually introducing new ideas and continually unsettling commercial arrangements in the various ways which Mr. D. A. Wells has so well pointed out. On the other hand, if science can be made to ever inculcate and reinculcate the idea of justice, it will do vastly more by that means to knit, than it possibly can in any other way to loosen, the bonds of society. Let us have science, then, in our schools; but let it not be a mere matter of experimenting with gases and acids, with air-pumps and electric machines, but let it be brought home as Nature's message to the hearts as well as to the minds of the young. Let it teach them justice; let it impress upon them that there is a right, that there is a true, that there are moral balances as well as chemical ones, that there are conditions of moral stability and instability just as of chemical or mechanical or electrical. The teacher who can not extract moral instruction and inspiration out of physical science ought to leave it alone—whether he is fit to teach anything is a question. There are countless useful analogies to be drawn between the laws of matter and those of mind and of society. To mention but one that occurs to us at this moment, the law of the expansion of gases with diminishing pressure is an apt illustration of the expansion of human desires with enlarging scope, or, in other words, as external pressure diminishes. As in the one case with every added volume the elasticity becomes less, so too often in human life, the more desires are gratified, the less there is of that elasticity of spirits which made life seem worth living.

The law of natural selection, again, might be made to teach many most useful lessons. It shows in the first place that, as the world is constituted, it is a great privilege to live. Then, if life is to be maintained on a satisfactory footing, it must be by the exercise of prudence, of industry, and whatever other virtues make for individual success. The thought that so many lives are abortive, far from cultivating pride or selfishness, should add a certain tinge of solemnity to all one's thoughts of life. "In me," each of us may think, "that spark which struggled vainly to maintain itself in so many others has become a living flame. How shall I use the powers so mysteriously bestowed and on which in many ways such vast issues depend? Shall I make life, as I ought, a sacred thing, or shall I pass my days in idle frivolity or yet more idle gloom? Seeing that I possess the gift of life, shall I not strive to raise it to its highest value and its best expression?" If life is a struggle, it is a struggle not so much against living competitors—that is a view of which quite too much is made—as against antagonist influences chiefly in the way of ill-regulated desires; and the law of natural selection rightly expounded will teach us that, if we wish to survive, we must cultivate all the qualities that make for fitness, and repress those that tend to produce unfitness.

LITERARY NOTICES.

The Earth and its Inhabitants. By Élisée Reclus. North America, Vol. I. New York: D. Appleton & Co. Pp. 496. Price, sheep, $6; half morocco, $7.

The American edition of this great descriptive work, by the eminent French geographer Reclus, has now reached the section devoted to North America. This division will probably require four volumes, the first of which is now before us. A chapter sketching the early discoveries in the New World and the chief features of the Western Continent introduces the volume. This is followed by detailed descriptions of the northern parts of the continent, comprising Greenland, the neighboring islands, Alaska, and the British possessions, including Canada. The physical features, flora, fauna, and inhabitants of each region are fully described. In the account of Greenland the glaciers of that ice-bound land are a prominent feature. Their distribution, extent, rates of movement, and mode of termination are described, and their appearance and arrangement are represented by many pictures and maps. The nature of the illustrations in this work is already known to our readers from the article on Greenland and the Greenlanders, in the Monthly for last July, for which some of them were borrowed. The geography of Alaska is given with much detail so far as it is known, and the progress of exploration in that Territory is sketched. Here, again, the glaciers demand considerable attention. Maps show the zones of temperature and trees, and the distribution of the native tribes and the animals is also pointed out. About three hundred and fifty pages are devoted to Canada and the other British provinces in North America. The reader is led from the rivers and fiords of British Columbia, through the wild Northwest Territory, among the posts of the Hudson Bay Company, and the lakes of the Winnipeg region, then down the St. Lawrence through Ontario and Quebec, to the Maritime Provinces, finally reaching Labrador and Newfoundland. The description deals with—besides the natural features—the social and political conditions, trade, languages, religions, etc., of the several divisions of the country. The full-page pictures, which are liberally scattered through these chapters, represent wild scenery of the central and western regions, the features and dress of the natives, and the large towns on the eastern rivers and seaports. The maps, which are very numerous, are from actual surveys, and hence contribute to the scientific accuracy which is characteristic of the whole work. Statistics of area, population, trade, etc., are given in appendixes.

The Meteoric Hypothesis: a Statement of the Results of a Spectroscopic Inquiry into the Origin of Cosmical Systems. By J. Norman Lockyer. London and New York: Macmillan & Co. Pp. 560. Price, $5.25.

The purpose of this volume is to bring together and co-ordinate the observations which have been made up to the present time on the spectra of the various orders of cosmical bodies in connection with laboratory work on which the author has been engaged since 1868. It embodies in a connected form, among other matters, various reports made by him through the Solar Physics Committee to the Royal Society. It is, in fact, a natural sequel to the Chemistry of the Sun, published in 1887, in which were presented researches suggesting that many solar phenomena might owe their origin to falls of meteoric masses on the sun's surface. The theory here presented is substantially an enlargement and extension to the universe of the hypotheses therein set forth. Beginning with a chapter of history and facts on the fall and nature of meteorites, the author treats in successive chapters of the Spectroscopy of Meteorites; Meteorites in the Air, in the Solar System, and in Space; Proposed New Grouping of Cosmical Bodies; the Origin of Binary and Multiple Systems; and the Variability in Light and Color of Cosmical Bodies. Among his principal General Conclusions are: that all self-luminous bodies in the celestial space are composed either of swarms of meteorites or of masses of meteoric vapor produced by heat. The heat is brought about by the condensation of meteor-swarms due to gravity, the vapor being finally condensed into a solid globe. That the existing distinction between stars, comets, and nebulæ rests on no physical basis; that stars, the temperatures of which are increasing, do not resemble the sun, but consist chiefly of discrete meteoric particles, just as comets do on Schiaparelli's hypothesis; and that the spectra of all cosmical bodies depend upon either the heat of the meteorites produced by collisions, and the average space between the meteorites in the swarm, or, in the case of swarms wholly volatilized, upon the loss by radiation since complete vaporization.

The Tshi-speaking Peoples of the Gold Coast of West Africa. Pp. 343.—The Ewe-speaking Peoples of the Slave Coast of West Africa. Pp. 331. By A. B. Ellis. London: Chapman & Hall.

The purpose of the author in these books, which constitute part of a series, is to show by examples taken from the negro peoples the subjects of them, how the evolution of religion may proceed. Four peoples have been had in view: the Tshi-speaking peoples of the Gold Coast; the Ga-speaking peoples of the Gold Coast; the Ewe-speaking peoples of the Slave Coast; and the Yoruba-speaking peoples of the Slave Coast. Their languages all belong to one family, indicating, apparently, that they have all sprung from a common stock. They occupy territories on the west coast of Africa contiguous in the order in which they are named, from west to east, and exhibit, on the whole, a gradual advance in civilization, in the same order. The author suggests that the differences in civilization may be due to differences in local conditions and surroundings and in the character of the country, which opens up from the forest regions of the west, where density of population is discouraged and communication is difficult, to the open plains of the Yoruba country. The religious beliefs of the Ga-speaking people resemble those of the Tshis, and are not considered for the present. Those of the Yorubas are reserved for a future volume. The best-known representatives of the Tshi-speaking tribes are perhaps the Fantis and Ashantis. Throughout the vast tract of forest inhabited by them, they live in insignificant villages and hamlets, built in small clearings in the forest, between which communication is kept up by narrow forest paths. Ideas permeate among them but slowly; and notwithstanding an intercourse on the part of the inhabitants of the sea-coast with Europeans, which has existed for more than four hundred years, they are much in the same social and moral condition as they were at the time of the Portuguese discoveries. The Ewe-speaking peoples, among whom are the Dahomis, present the ordinary characteristics of the uncivilized negro. In early life they evince a degree of intelligence which, compared with that of the European child, appears precocious, and they acquire knowledge with facility till they arrive at the age of puberty, when the physical nature masters the intellect, and frequently deadens it. Like most inhabitants of the tropics, they have more spontaneity and less application, more intuition and less reasoning power, than the inhabitants of temperate climes. These traits, of both peoples, are ascribed partly to the climate, partly to physical peculiarities, and partly to the social condition and the general sense of insecurity. As a result of all the inimical influences, the energy of all has degenerated into idleness and sensual enjoyment, "and it will take centuries to raise them." Incidentally, in collecting information concerning the religion of these peoples, the author also gathered facts concerning other matters—their laws, government, various customs, proverbs, folk-lore, etc.—and these subjects are also presented, not as in a full record, but to fix a starting-point from which a systematic and more complete study may be made.

Geological Survey of New Jersey. Final Report of the State Geologist. Vol. II, Part II. Zoölogy. Trenton. Pp. 824.

The present "part" of the final report of the late Prof. Cook contains two papers: A Catalogue of Insects found in New Jersey, by John B. Smith; and a Descriptive Catalogue of Vertebrates, by Julius Nelson. Mr. Smith confesses to having had to encounter many difficulties in preparing his catalogue of insects. The contrasts in the geological features of the State influence the botany, and this affects the character of the insect forms. There are no large collections of insects in the State. Collectors are few. Some aid was got from collectors in New York and Philadelphia, but their excursions into New Jersey covered only a limited area, and were mainly directed in special lines. Except in Coleoptera and Lepidoptera, New Jersey is practically unexplored, and the northern and northwestern regions are not represented, even in the collected orders. The author himself, collecting in all orders, in different parts of the State, though for too short a time, has been able to add considerably to all the lists, from his own experience. His catalogue includes 6,093 species, of 2,307 genera and 238 families, and is arranged after the Linnæan system. Mr. Nelson's catalogue of vertebrates is a revision of Dr. Abbott's catalogue of 1868, and it has been found a laborious task merely to incorporate the changes in nomenclature and classification which have been made within the last twenty years. Mr. Nelson has added descriptions of each species, with particular reference to features distinguishing it from its allies; and the descriptions have been made most complete for birds and fishes.

Principles of General Organic Chemistry. By Prof. E. Hjelt, Helsingfors. Translated by J. B. Tingle, Ph. D. London and New York: Longmans, Green & Co. Pp. 220.

Every one who has had anything to do with the teaching of organic chemistry will assent to the statement of Prof. Hjelt that students are very apt to overlook general principles and relations in their endeavor to remember particulars concerning single substances. To remedy this defect he has made a book, intended as a supplement to ordinary text-books, which is devoted to the chemical philosophy of the carbon compounds. Its object is to extend and systematize the knowledge of these substances which the student has obtained from other sources. In Part I the composition, constitution, and classification of organic compounds are discussed and explained. Part II is devoted to illustrating the connection between the constitution of organic compounds and their chief physical properties. Part III deals with the chemical behavior of organic compounds. The reactions described in this section are arranged according to the results—dehydration processes, for instance, being all classed together. Two editions of the work having been received favorably in Swedish, a German version was prepared by the author, and from the latter the English translation has been made.

The Coast Indians of Southern Alaska and Northern British Columbia. By Ensign Albert P. Niblack, U. S. N. Washington: Smithsonian Institution. Pp. 161.

There is much to tell about the Alaskan "wards of the nation" and their relatives in the British dominions. Sufficient evidence is given in this monograph to show that the Indians of the Northwest coast have a high degree of skill in many arts, industries, and pursuits, a systematic tribal organization, interesting customs and ceremonies, and traditions and folk-lore which are instructive to the student. The information here presented is based on the collections of objects in the United States National Museum, and on the personal observation of the author in connection with the survey of Alaska. Subdivisions of the above topics are treated with varying fullness in fifteen chapters, the text being illustrated with seventy full-page plates. The carvings in wood and slate, and the woven garments and baskets here figured, display much ingenuity, while the accounts of the way in which these peoples have adapted themselves to the ways of civilization give proof of much mental strength.

Inorganic Chemistry, Theoretical and Practical. By William Jago, F. C. S. London and New York: Longmans, Green & Co. Pp. 458.

The author of this work is an experienced writer of chemical text-books. The present volume is described as a manual for students in advanced classes—that is, for those who have some acquaintance with the common elements, and some knowledge of chemical reactions. It does not omit any essential subject, but elementary matters are treated briefly, while larger space is given to the laws of chemistry and to manufacturing processes. A feature of the book is a brief statement of the industrial applications of all substances that have important uses. The volume is well printed, and contains seventy-eight illustrations and a colored plate of spectra.

A very attractive and well-made text-book for beginners is the *Elementary Geology*, by *Charles Bird*, which is one of Longmans' Elementary Science Manuals (Longmans, 80 cents). It is written in a simple and easy style, giving a vivid idea of how geological changes have taken place, and with examples, mostly English, of the formations described. The economic use of each rock mentioned is also generally stated, and there are 247 helpful illustrations, and a colored geological map of the British Isles. The sort of teaching that the author gives is well indicated in his preface. He reports the successful use of the lessons in this book before they were printed, saying that they sent many town boys on long walks into the country, and enabled practically the whole class to pass the South Kensington elementary examination. But he deems the abiding interest aroused in natural phenomena and outdoor objects "a more valuable and useful possession than even a South Kensington certificate."

A *Text-Book of Practical Plane and Solid Geometry*, by *I. H. Morris*, has been added to the same series (Longmans, 80 cents). It is devoted to the construction of geometrical figures or geometrical drawing, and contains several hundred problems, which range from the simplest to those of considerable complexity. The part of the volume dealing with plane geometry leads up to the drawing of spirals of different kinds and other curves. This is followed by a chapter on the application of geometry to the construction of patterns and simple tracery, including geometrical tracery windows. The drawing of plans, elevations, and sections of solids, such as prisms, pyramids, and cones, in simple positions is then taken up. The second section of the book deals with the projection of points and lines, and the representation of planes by their traces on co-ordinate planes, and also the projections of solid objects of simple form. Lists of exercises consisting of problems taken from the examination papers of various English colleges are introduced at intervals. The diagrams appear in all cases on the page opposite the problems.

The *Geography of Europe*, by *James Sime*, corresponds in character with the preceding volumes of Macmillan's Geographical Series, to which it belongs (Macmillan, 80 cents). The chief feature of the book is the attention it gives to the past evolution of political divisions. The historic associations of towns have also been made prominent. The author states, as to the information he has aimed to include in the volume: "In the case of each country the physical features are first described; then an attempt is made to mark the stages of its history, so far as they are related to geography. Next I have brought together some of the leading facts relating to government, population, and national character, religion and education, and industry and trade. Finally, an account is given of the principal towns, these being generally grouped under the historic divisions to which they respectively belong." As there is a volume devoted to the British Isles in this series, only a short chapter on the United Kingdom is included in the present work. There are thirty-three cuts representing characteristic buildings and places.

In the same series has just appeared a volume on *India, Burmah, and Ceylon*, by *Henry F. Blanford* (price, 70 cents). The subject-matter of this book may be described as wholly geographical, and the author says that, in order to bring so large a subject within less than two hundred pages, it has been necessary to restrict the description to the most important features. But few historical allusions are to be met with in these pages. The text is illustrated with twenty-seven cuts. Neither this nor the preceding book contains maps, as both are designed to be used with an atlas.

From the Smithsonian Institution we have received a number of monographs, in pamphlet form, which are to constitute parts of volumes soon to be issued. *The Report on the National Museum for 1888*, by *G. Brown Goode*, assistant secretary in charge, contains some facts in regard to the history and organization of the museum, a review of the work of the year, a list of the more important accessions, and other information. During the year a Department of Living

Animals was organized, which the secretary hopes will develop into a national zoölogical garden. Among these pamphlets is a paper by *Walter Hough*, on *Fire-making Apparatus in the United States National Museum*. It contains descriptions of a large number of ways of making fire, with sixty cuts of apparatus. The methods are classified and arranged in their presumed order of development as follows: Fire-making by twirling one stick on another, by sawing and by plowing one stick with another, by striking flint and pyrites together, and flint and steel. Most of these methods have been used by the Indians or Eskimos of America. *A Study of Prehistoric Anthropology*, designed as a hand-book for students beginning this science, has been prepared by *Thomas Wilson*, curator of this department in the National Museum. It is a general view of the subject, with a bibliography and many cuts representing implements of stone, bone, bronze, etc., dolmens, vessels, ornaments, and human representations. *Frederic A. Lucas* has prepared an account of *The Expedition to the Funk Island*, which he made in 1887, to procure bones of the great auk. The bones obtained equaled in number all other collections combined, and a thorough exploration was made of the island. The paper is illustrated with a picture of the bird and one of its egg, a sketch map of Funk Island, and diagrams. A popular account of this expedition was contributed by Mr. Lucas to the Monthly for August, 1888. *A Catalogue of the Hippisley Collection of Chinese Porcelains, with a Sketch of the History of Ceramic Art in China*, prepared by *Alfred E. Hippisley*, is now published. In 1887 this large collection was deposited in the National Museum, with the understanding that it should be allowed to remain on exhibition for at least two years, and that the museum should print a descriptive catalogue. The catalogue occupies some fifty pages, containing 438 numbers, and the history of ceramic art is quite extended.

Several Bulletins of the Geological Survey have reached us together. No. 58 contains a paper on *The Glacial Boundary* in the Central States, by Prof. *G. F. Wright*, with an introduction by *T. C. Chamberlin*. It is occupied mostly with observations on the distribution of the till, but contains also some facts in relation to striated surfaces of rocks in place. The paper contains also the evidence for and against the hypothesis of a glacial dam at Cincinnati. Recent finds of palæoliths pointing to the probable existence of interglacial man in Ohio are here reported; the relation of the loess to the glacial drift, and the finding of gold near the glacial margin, are also touched upon. Eight plates and ten figures illustrate this monograph. No. 59 is by *Frederick D. Chester*, on *The Gabbros and Associated Rocks in Delaware*, the massive gabbro being the most prominent formation in the northern part of that State. The paper is illustrated by a map and five figures. A *Report of Work done in the Division of Chemistry and Physics* for the year 1887–'88, by *F. W. Clarke*, forms No. 60. It contains an extended account of the occurrence and utilization of natural soda, by Thomas M. Chatard, analyses of various rocks, ores, waters, and meteorites, and notes on a number of other subjects. No. 64 is a similar report for 1888–'89, and is occupied largely with examinations of minerals. No. 61 is *Contributions to the Mineralogy of the Pacific Coast*, by *William H. Melville* and *Waldemar Lindgren*, the objects of study being cinnabar crystals and other specimens collected during a recent examination of the quicksilver deposits of California. *A Bibliography of Palæozoic Crustacea*, by *Anthony W. Vogdes*, forms No. 63. It comprises a list of authors, a catalogue of trilobites, and a catalogue of non-trilobites. No. 66 is *On a Group of Volcanic Rocks from the Tewan Mountains, New Mexico, and on the Occurrence of Primary Quartz in Certain Basalts*, by *Joseph P. Iddings*. We have also received a paper by *Charles A. White*, entitled *On the Geology and Physiography of a Portion of Northwestern Colorado and Adjacent Parts of Utah and Wyoming*, which is to form a part of the report of the Geological Survey for 1887–'88. The district here described lies round about the Uintah Mountains, and the phenomena specially considered relate to its geological structure and to surface drainage. A colored geological map of the region and a number of diagrams are given.

The object of the series of reports on the *Mineral Resources of the United States*, of which Mr. *David T. Day*, Chief of Division of Mining Statistics and Technology, is the editor, is to record annually the most important facts concerning the development of the minerals found in the country. The present, the sixth volume, is for the year 1888. The method of treatment pursued in the previous volumes is continued in this. The report opens with a summary statement as to the condition of each mineral industry at the close of the period under review—the calendar year. At the end of this summary is a table in which the values of the various products are added, so as to furnish an estimate of the relative importance of the mining industry as a whole. Following the summary each important mineral industry is discussed in a separate chapter. The statistical tables given in former reports are extended to include 1888, but otherwise the material in each chapter is intended to show the developments in 1888 only and not in previous years. To facilitate the consultation of all the volumes of the series, an index to the six is in preparation. (Government Printing-Office, Washington.)

Volume XXIV of the Annals of the Harvard Observatory is devoted to *Results of Observations with the Meridian Photometer*, from 1882 to 1888, by *Edward C. Pickering* and *Oliver C. Wendell*. The measurements are of stars having magnitudes brighter than 9·1 of the Durchmusterung. The objects observed number 20,982. Four photometric settings were made upon each object, and these were repeated on the average between three and four times. The total number of settings is 267,092.

The *Elements of the Differential and Integral Calculus* of Prof. *Arthur Sherburne Hardy* (Ginn & Co.) is based on the system of rates which, in the author's experience, has proved most satisfactory in a first presentation of the object and scope of the science. The object of the Differential Calculus is the measurement and comparison of rates of change when the change is not uniform. The rate at any instant is determined by ascertaining what the change of a quantity would have been in a unit of time had its rate remained what it was at the instant in question. This change the Calculus enables us to determine, however complicated the law of variation may be.

The Bureau of Education has issued, among its Circulars of Information for 1890, a book of some four hundred pages on *The Teaching and History of Mathematics in the United States*, by Prof. *Florian Cajori*. The first chapter, dealing with elementary schools, the colleges then existing, and self-taught mathematicians in colonial times, describes persons and ways of teaching, many of which seem very quaint to modern eyes. The next two periods treated cover respectively, the influx of English mathematics and the influx of French mathematics. The list of colleges grows longer in these two chapters, and among the other topics which now enter into the history are the surveying of Government lands, mathematical journals, and the United States Coast and Geodetic Survey. A chapter on mathematical teaching at the present time contains the answers obtained by sending a list of questions to several hundred colleges, normal schools, academies, etc. This is followed by several historical essays on mathematical subjects, and a bibliography of fluxions and the calculus.

The Laboratory Manual of Chemistry, Medical and Pharmaceutical, by *Oldberg and Long*, which we noticed in July, 1888, has come out in a revised and enlarged edition (Keener, $3.50). The preface states that the greater part of this edition is an exact reprint of the first, but that the chapter on the chemical analysis of urine has been entirely rewritten, and a new chapter has been added on the microscopic examination of the sediment.

Mr. *Westel W. Willoughby*, in his monograph on the *Supreme Court of the United States* (Baltimore, Johns Hopkins Press), holds up that tribunal as an illustration of the maxim that in America, as elsewhere, institutions are the result of an evolution, and not an invention; and that constitutions, whether written or unwritten, are but the results of the gradual recognition of those laws and methods which are the best suited for the government of a politically organized people. The history of the Supreme Court begins with accounts of the judiciaries in the colonies and under the Confederation, and is carried on through the Convention, the State Conventions, the establishment and jurisdiction of the Federal Courts; with reviews of the relations of the Supreme Court with Congress, the State Legislatures and Judiciaries, and the Executive; the Supreme Court and politics; the present condition and needs of the Supreme Court; and the conclusion, resulting in the assertion that it should be a matter of special congratulation that "of all our great institutions the Supreme Court is most distinctly the product of American genius, and that its success is a direct testimony to the high political ability of our American people."

Bulletin No. 6 of the Eleventh Census is a preliminary statement of the *Financial Condition of Counties.* It has been prepared by Special Agent *T. C. Copeland*, and shows the bonded, floating, gross, and net debt, sinking fund, available resources, and annual interest charge of each county in the United States. The Bulletin contains also a series of maps illustrating the geographical distribution of county debt and resources. Bulletin No. 19 gives partial results of an inquiry into the *Vital Statistics of the Jews in the United States*, conducted by Dr. *John S. Billings.* A discussion of the tables by Dr. Billings brings out the apparent fact that the birth-rate is decreasing and the death-rate increasing among the Jews with prolonged residence in this country.

Economic subjects are being written upon to-day by thoughtful men in every calling. A recent addition to the volume of literature thus produced is *The Distribution of Wealth*, by *Rufus Cope* (Lippincott, $2). It embodies the author's opinions on the production of wealth, its division between labor and capital, savings, interest, taxation, protection and free trade, monopolies, and allied topics, closing with a chapter on education of the people, secular and religious. It also contains full and free comments on certain recent books and magazine articles, and in some cases the writers are criticised as well as their published views. On the question at present most prominent—the tariff—the author takes the position of an apologist for protection. Throughout the volume his statistics are for the most part those of the census of 1880, although his table of tariff revenues is only three years old. From education, he hopes that the working classes will gain much in the way of bettering their condition.

A quarterly magazine called *The Monist* has been established, with the stated object of continuing a portion of the work hitherto done by The Open Court (The Open Court Publishing Company, $2 a year), or of developing "a unitary conception of the world, free from contradictions and based upon the facts of life." A result which is expected to flow from the accomplishment of this task is a purification of our religious ideals. The opening article of the first number is a reply by G. J. Romanes to certain statements of A. R. Wallace on Physiological Selection. The line of this reply is that Mr. Wallace has professed hostility to the views of Mr. Romanes and Mr. Gulick, and afterward reproduced them as original. Prof. Cope contributes an analysis of The Material Relations of Sex in Human Society, from which he draws the conclusion that, while woman is under some social disadvantages in respect to man, these are based on facts of nature which can not be changed, and that she has a full equivalent in advantages which are also derived from the natural order of things. Other articles in the number are The Immortality of Infusoria, by Alfred Binet; The Analysis of the Sensations—Anti-metaphysical, by Prof. Ernst Mach; The Origin of Mind, by Dr. Paul Carus; The Magic Mirror, by Max Dessoir; and Höffding on the Relation of the Mind to the Body, by W. M. Salter. There is also an installment of Literary Correspondence from France, by Lucien Arreat, a department of book reviews, a conspectus of the instruction in philosophy given at leading American colleges, and a list of psychological and philosophical articles in other periodicals.

Inquirendo Island, by *Hudor Genone* (Twentieth Century Publishing Company, $1), is a satirical story dealing with theological matters. Extracts from reviews on the slip sent out by the publishers show the religious press to be divided as to whether the book is religious or irreligious.

The Standard Dictionary of the English Language, to be published by Funk & Wagnalls, is intended to be such a dictionary as the people will find most useful for daily consultation. While the wants of scholars will not be overlooked in its preparation, those of lay readers will be preferred. For this reason some departures will be introduced in it from the usual custom of dictionaries. Besides the spelling and pronunciation of the word, the first thing sought by the average man is its most common present meaning. For that reason, the meaning now most generally accepted is given first, while the less usual meanings and the obsolescent and obsolete meanings are remanded to back places. The etymologies are given after the definitions. The quotations by which the meanings are illustrated will be verified by reference to the particular work, chapter, and page of the author cited, in which the word is found. A large proportion of the verifying quotations are from the standard writers of the day; and, as between a foreign and an American author of equal authority, the American will be preferred. Pronunciations will be indicated in the alphabet suggested by the American Philological Association. The various departments of the work are to be prepared under the direction of scholars eminent in their respective specialties. The dictionary will be published in a single volume of more than twenty-one hundred pages, a little larger than the pages of the unabridged dictionaries, will be illustrated, will contain the usual supplements, and will be sold for $10 a copy, with a special discount to advance subscribers.

PUBLICATIONS RECEIVED.

American Academy of Medicine. Bulletin on the Value of Academical Degrees. Pp. 8.

Bellamy, B. W., and Goodwin, M. W. Open Sesame. (School Reader.) Ginn & Co. Pp. 361.

Burney, S. G. Studies in Psychology. Nashville, Tenn.: Cumberland Presbyterian Publishing House. Pp. 535.

Calendars for 1891. Styles & Cash, printers, New York.—E. B. Treat & Co. Don't forget it Calendar.

Charity Organization Society, New York. Directory of Charities. Pp. 400.

Children's Aid Society, New York. Tenth Annual Report. Pp. 80.

Coy, Edward C. Greek for Beginners. American Book Company. Pp. 152.

Cresson, Dr. C. M. Water-supply and Disease in Philadelphia. Pp. 24.

Census, United States, Bulletin. Vital Statistics of Jews. Pp. 24.

Fall, Delos, Albion, Mich. Action of Alcohol on the Human Body. Pp. 16.

Fontaine, W. M., and Knowlton, F. H. Triassic Plants from New Mexico. Smithsonian Institution. Pp. 6, with Plates.

Foulke, William Dudley. Civil-service Reform in its Later Aspects. Society for Political Education, New York. Pp. 13.

Genone, Hudor. Inquirendo Island. New York: Twentieth Century Publishing Co. Pp. 347. $1.

Geological Survey, United States. Bulletins: No. 58. Glacial Boundary, Pennsylvania to Illinois. By G. F. Wright. Pp. 44.—No. 59. Gabbros, etc., in Delaware. By F. D. Chester. Pp. 40.—Nos. 60 and 61. Reports of the Division of Chemistry and Physics, 1887-'88 and 1888-'89. By F. W. Clarke. Pp. 150 and 60.—No. 61. Mineralogy of the Pacific Coast. By W. H. Melville and W. Lindgren. Pp. 33, with Plates.—No. 63. Bibliography of Palæozoic Crustacea. By A. W. Vogdes. Pp. 177.—No. 66. Volcanic Rocks from Tewan Mountains, New Mexico, etc. By J. P. Iddings. Pp. 34.

Gilbert, G. K. Lake Bonneville. Pp. 438. Washington: United States Geological Survey.

Hale, E. M., M. D., Chicago. Are Valvular Diseases of the Heart curable? Pp. 4.

Hamilton, Gail. A Washington Bible Class. D. Appleton & Co. Pp. 303. $1.50.

Harding, George. Argument on Patent Suit. Self-carrier for Self-binding Harvesters. Philadelphia. Pp. 124.

Heilprin, Prof. Angelo. Corals, etc., of the Gulf of Mexico. Pp. 14, with Plates.

Iowa, University of, Engineering Society. The Transit. Vol. I. No. 2. Pp. 96, with Plates. 50 cents.

Ivers, J. E. Echinoderms from the Northern Coast of Yucatan, etc. Pp. 24, with Plate.

Lockyer, J. Norman. The Meteoric Hypothesis. Macmillan. Pp. 560. $5.25.

Maclean, J. P. Fingall's Cave. Cincinnati: Robert Clarke & Co. Pp. 49. 75 cents.

Madison, Andrew W., New York. The True Theory of Christianity. Pp. 86. 15 cents.

Nichols, Prof. E. L., Cornell University. The Artificial Light of the Future. Pp. 21.

Norton, C. L. Political Americanisms. Longmans. Pp. 134. $1.

Pennsylvania, University of. Museum of Archæology. Annual Report. Pp. 54.

Powell, J. W. United States Geological Survey. Ninth Annual Report. Pp. 717, with Maps and Plates.

Powers, Edward, Delavan, Wis. War and the Heathen. Pp. 202. $1.

Stone, George H. Glacial Sediments of Maine. Pp. 24.

Tolstoi, Count Leo. The Fruits of Culture. Boston: Benjamin R. Tucker. Pp. 185.

Tourgee, Albion W. Murvale Eastman, Christian Socialist. Fords, Howard and Hulbert. Pp. 545. $1.50.

Wheeler, George Montagu, U. S. A. A Universal World's Exhibit. Washington. Pp. 6, with Chart.

Whitman, C. O., Boston. Marine Biological Laboratory. Report. Pp. 27.

Williams, G. H. Elements of Crystallography. New York: Henry Holt & Co. Pp. 250.

Wilsing, J. Determination of the Mean Density of the Earth. Smithsonian Institution. Pp. 12.

POPULAR MISCELLANY.

White-fish in Lake Ontario.—A number of citizens of Rochester are endeavoring to interest the people of the State of New York in stocking Lake Ontario with white-fish. The lake once afforded abundance of this sweet and juicy fish, as Lake Erie does still, but they have now become scarce in it. The citizens to whom we refer show that Ohio, Michigan, Illinois, Wisconsin, and the Dominion are busily stocking their lakes; while New York, with Ontario and numerous smaller lakes adapted to the raising of white-fish, is doing comparatively little in this particular direction. "We ought," they say, "to put out from thirty million to fifty million white-fish per annum." For this purpose we need regular and yearly liberal appropriations for stocking the lakes; stringent laws against netting or fishing during the spawning season or on spawning beds; laws forbidding the use of nets with a mesh smaller than is defined in them, and the catching and marketing of fish of less than a determined weight; the appointment of a first-class fish warden with enough deputies; and co-operation with the national and Dominion Governments.

The American Folk-lore Society.—The Council of the American Folk-lore Society reported at the recent meeting of that body that it stood upon a more solid basis than ever before, and its existence no longer needed to be justified. It may be confidently affirmed that no branch of American historical research offers a field for original investigation comparable to that presented by the traditions, rites, beliefs, and customs of the aboriginal races. On the other hand, the rapidity with which these tribes are penetrated by the ideas of civilization is strikingly illustrated by the movement now in progress among the Indian tribes of the United States. Every year, by increasing the difficulty of research, adds to the likelihood that many problems of primitive religion and usage will, in consequence of deficiency of information, remain permanently unsolved—a failure which, again, must of necessity obscure the comprehension of more advanced developments of human intelligence. It is therefore greatly to be desired that to the task of collection shall be devoted an energy in some degree commensurate with its importance, and that labors in this direction should be extended and systematized. As respects other branches of the work, especially observations concerning immigrant races, the material already printed in the publications of the society has been sufficient to demonstrate the various interest of the subject, the width of the field open to the collector, and the manner in which existing habits and beliefs serve to illustrate history. The Council has decided, if the society consents, to begin the publication of a Library of American Folk Lore, of which two volumes may be issued annually. While no member will be required to subscribe for these works, they will be obtainable for a subscription of two dollars in addition to the membership fee of three dollars, making the whole expense five dollars—for which all the regular publications of the society will be sent. The establishment of local chapters, which has already been successfully carried into effect in Philadelphia and Boston, is recommended. The society had four hundred and forty-seven members, with applicants enough to swell the number to more than five hundred. The Journal of American Folk Lore, the society's publication, is already, according to the statement of Prof. Crane, one of the editors, accepted as an authority in this country and in Europe.

The Bath in the Middle Ages.—An assertion made several years ago by Dr. Lyon Playfair, trusting to "worthless authorities," that "for a thousand years there was not a man or woman in Europe that ever took a bath," which was laughed at at the time, has been seriously refuted by the Rev. T. E. Bridget in his historical essay on Blunders and Forgeries. According to him, no one who has read much of the mediæval literature of any part of Christian Europe can doubt that the bath was constantly called into requisition. Among the accounts of Queen Isabella, wife of Edward II, is an entry of a payment "for repairs of the queen's bath and gathering of herbs for it." In a narrative of the arrival of Louis of Bruges, created Earl of Winchester in 1472, we find among other comforts provided for him that in the third chamber there "was ordered a *Bayne*, or ij, which were covered with tentes of white clothe." Mr. Dickson, the editor, tells us in the preface to the first volume of the Accounts of the Lord High Treasurer of Scotland, that "bathrooms were not uncommon in the houses of the great, and even the luxury of baths in bedrooms was not unknown. The accounts show two payments for broadcloth to cover a 'bath-fat'—that is, to form a tent-like covering over it." The Abbé Thiers, in his Traité des Superstitions, mentions certain days on which silly people fancied it was wrong to bathe, a notion which would never have arisen had not bathing been a common practice.

The Battersea Home for Dogs.—The Battersea Temporary Home for lost and starving dogs took care last year of 24,123 dogs, for 3,613 of which homes were found—either new homes or by restoration to their owners. The report says that homeless dogs coming from the London streets were for the most part untrained, ill-bred, deformed, diseased, and half-starved, which, by the necessities of the situation, "found in the lethal chamber a merciful refuge." The muzzling order greatly augmented the number of dogs sent to the home during the latter part of the year, and threatened to overwhelm the resources of the institution. The home had prevented the spread of rabies by clearing the streets of the dogs most liable to be bitten by rabid animals, and had thus benefited the whole community. A cats' home had been added for the boarding of these animals, and neglected pussies were now found new homes or sent to the lethal chamber. The Duke of Portland—who presided at the annual meeting of the society—expressed his satisfaction at the personal interest which was shown by the Queen in the work of the home, as was proved by "her interposition to lengthen the time between the incoming of the dogs and the consequences of no one claiming them"—which is a beautifully delicate way of phrasing the unpleasant truth.

The Failure of the Apple Crop of 1890.—The failure of the apple crop of 1890 in western New York is accounted for by Prof. L. H. Bailey, of the Cornell Experiment Station, as a result of the weather, which was exceedingly wet and cool in the spring, then marked by unusually heavy rains, followed by drought. A blight was developed in the foliage of the trees, caused by the growth of the apple-scab fungus. The scab (*Fusicladium dendriticum*) is found upon the bracts or small leaves attending the flower-cluster, and is frequent upon very small fruits. It is nearly always present, to a greater or less extent, upon both leaves and fruit, but it is rarely so destructive to foliage as in the last year. It has increased rapidly in New York of late years, and apples have been unusually scabby. The wet spring afforded it just the conditions for rapid growth. The scab appears to be somewhat worse upon low and undrained lands than upon high and warm elevations, although in the infected regions the latter are never exempt. A closely related species (*Fusicladium pyrinum*), by some regarded as identical with the other, attacks the pear, in fruit and foliage, and probably causes much of the failure in the pear crop. It has a tendency to remain in more or less definite spots, so that pear foliage rarely looks as brown as apple foliage. The injury to trees by the fungus is not vital. It is best counteracted by spraying with solutions of carbonate of copper, beginning before the flowers open, and making four or six applications between then and the 1st of August. A solution of copper sulphate, carbonate of soda, and carbonate of ammonia is also recommended.

Advent of the Ghost Idea.—Lady Welby offered a puzzle to the British Association when she presented the question, which has not been solved, of accounting for the great "break" in human thought which occurs when the "ghost idea," or the thought of another life and the supernatural, comes in. The governing notion of those who regard the human intellect as a result of evolution is that man slowly accumulated experience, and from it, by comparison, by deduction, and by meditation, arrived at last at abstract and non-material thought. He considered the effect of revenge, for example, and its operation on tribal society, till he arrived at the idea of just revenge, or, as we call it, of justice; and, finally, his horizon ever widening, at the lofty conception that forgiveness might occasionally, or even frequently, be more to the general advantage, or, in other words, might be nobler, and therefore to be adopted. This theory leaves much unexplained, but it is supported by an array of facts, and will, if accepted, explain many of the phenomena. Much of thought is a result of experience and observation, and more may be; and it may be possible to extend the result of teaching by experience till it covers most of the field of human intelligence. But a break occurs at the moment when the ghost idea intrudes. That can not be derived from experience; for no man has ever lived again the present life, nor has a ghost ever been observed except in fancy, and if in fancy, how did the fancy originate? It can not be explained, either, as the result of dreams, for, while people may dream odd things and whimsical combinations, they do not dream absolutely new things—that is, things outside their experience and outside the imagination developed from thinking about the collected results of experience either personal or inherited. Two suppositions are mentioned by the London Spectator in reviewing Lady Welby's paper as admissible on the subject. The first is that primitive man had evidence that he had seen or heard, at some time or other, that which inspired conviction in his mind, and became sure of another life because he had watched its manifestations. The other is that, whatever be the truth about the evolution of thought, some thoughts must be intuitional—that is, have been generated in man originally by some external power.

Chinese and Indian Tea.—The supremacy of the tea trade is gradually shifting from China to India and Ceylon to such an extent that the Chinese Government is said to have instituted an investigation into the matter. The cultivation of tea as an industry is hardly fifty years old in India, and not more than ten years old in Ceylon; yet the British importations from those countries almost equal in weight and exceed in money value those from China; and while the exports of China tea doubled between 1866 and 1886, those of Indian teas increased fourfold. The causes of the change were found by the Chinese investigation to rest largely in differences in the preparation of the commercial product. The Chinese method is characterized as careless. The crop is raised in small gardens by men who own them and whose capital is small. The picking is done by the family, with hired help only when it can not be got along without. To save expense it is pushed forward, and the plucked leaves are allowed to stand, deteriorating in quality, till it is finished. Consequently, the leaves are not evenly withered. In India, tea is grown in large gardens, under skilled superintendence, with thoroughly organized methods. The picking is attended to with extreme care, so that each leaf is plucked at the proper stage, the plants being gone over again and again as the leaves successively mature. The plucked leaf is started at once on the course of "making," so that no time is given for deterioration to begin. Like differences in care and system prevail through all the details and processes, down to the packing and transporting to market; and the Indian teas are prevailing by virtue of the real superiority which they thereby obtain.

Infant Serpents.—As described by Dr. Walter Sibley, in his paper in the British Association on The Incubation of Serpents' Eggs, the first sign of the process of hatching is a slit, usually V-shaped, appearing at the highest part of the egg-shell, whether the egg is placed on its side or on one end. The snout of the young reptile appears at the crack. After a time the head is protruded, and often remains out of the shell for some hours before the body and the tail are hatched. If disturbed, the head is again withdrawn into the shell. The author had seen fully-hatched young snakes return into their shells when alarmed. The young snakes, when first hatched, are smooth and velvety to the touch, with the yellow ring (of the common English snake) beautifully marked from the first, and the eyes open; but often there is some opacity about the cornea, which disappears in the course of a few hours. They are about six inches long, and weigh about eighty grains. They begin to hiss in the first few days.

Compressed Air as a Motor Power.—The power of compressed air was described by Prof. Alan Lupton, at the British Association, as suitable for large or small motors, and one that could be cheaply and safely introduced into workshops, houses, and shops. It will do the heavy work of a mill-course or iron-works, and the light work of the tailor, shoemaker, hair-dresser, and grocery, and will drive a dynamo for electric lighting. In Birmingham, by the agency of three steam-engines of 1,000 horse-power, air compressed to a pressure of forty-five pounds above the atmosphere is delivered into pipes which are laid like gas-pipes over four miles of streets. The works had only left the hands of the contractors, when there were forty customers for air-power, some of them at a distance of a mile and three quarters from the compressing station. The loss of power by friction in the pipes is so light that no ordinary gauge will show it. The engines of the consumers vary in size from half a horse-power up to fifty horse-power. Under the system of Hughes and Lancaster, by which compressed air may be applied to tramways, a pipe is laid in the street for the supply of compressed air to the cars, which carry the machinery for propulsion. Any gradient which a locomotive can mount can be ascended by the cars, and fresh supplies of air can be taken in without stopping the cars.

Petroleum as an Explosive.—Experiments by Peter T. Austen exhibit petroleum as an explosive of the dangerous class. It evolves inflammable gases at ordinary temperatures, and some of them are not liquefied by a considerable reduction of the temperature. The author applying a match to a flask containing crude petroleum at zero Fahrenheit, the flask was filled with a blue flame. Since the evolution of gas is increased by shaking the oil, an inflammable gas must accumulate in the vacant parts of car-tanks, in a condition more or less favorable to explosion. If the gas in contact with the petroleum becomes ignited, the oil will, in most cases, take fire unless the body of the liquid is very cold; and the danger increases as the temperature. The behavior of a tank of petroleum under pressure has not been much studied; but all know how tinder may be ignited in a "fire syringe"—an effect of simple compression. The lubricating oil of the piston also takes fire—at a temperature of about 300°. The volatile gases of petroleum may be ignited at a lower temperature. If the mixture of air and vapor over petroleum is compressed to one fourth its volume, the temperature will be raised to 429° from zero, and to 499° from 70° Fahr. It follows, therefore, that if an oil-tank filled or partly filled with such a mixture is suddenly compressed in such a way as greatly to reduce its volume, the gas, and probably the oil, will be ignited by the compression. This might happen in a case of telescoping or of a fall of the tank. If a tank nearly filled with oil were suddenly compressed, the resistance offered by the liquid would heat it sufficiently to cause an evolution of its lighter hydrocarbons in sufficient quantity to create a dangerous pressure within the tank. This might happen when, the car being stopped in a collision, the oil is suddenly hurled against the front end of the tank. The author concludes that precautions against explosion are necessary in the transportation of crude petroleum.

Alcohol as a Cause of Disease.—Dr. Lewis D. Mason, of the Inebriate Asylum, Fort Hamilton, N. Y., discussing The Etiology of Dipsomania and the Heredity of Alcoholic Inebriety, determines as facts that alcoholism in progenitors will produce physical and mental degradation in their descendants, with the disorders that arise from a defective nerve organization; and all grades of mental weakening, from slight enfeeblement of intellect to insanity and complete idiocy; and that the laws regulating these changes are similar to those that govern congenital degenerative changes from other causes. The offspring of the confirmed drunkard will inherit either the original vice or "some of its countless Protean transformations." In another paper—on Pathological Changes in Chronic Alcoholism—Dr. Mason exhibits alcohol as modifying the serum and the anatomical elements of the blood, besides being an irritant and directly producing modification and degeneration of tissue, and therefore as being most evidently a disease-producing agent. Contrasting the little progress that has been made in the study of the pathology of chronic alcoholism and of the diseases incident to alcoholism with the great advance that has been achieved in knowledge of microbic diseases, he adds: "Alcohol has not any microbe, but the grand total of its mortality will exceed the combined effect of all the bacteria that have ever passed the microscopic field or developed in the culture-tube of the bacteriologist." The subject is now, however, beginning to receive some of the attention it deserves.

Leaf and Stick Insects.—The leaf insect and the walking-stick insect are curious creatures. All of the family to which they belong are nocturnal in habit, and spend their days resting on trees and bushes the leaves of which form their food. They so resemble the leaves and twigs as to escape all but the very keenest observation. In the leaf insect, the head and thorax form a stalk, while the abdomen, which is flat, thin, and much dilated, exactly resembles a leaf. The six legs have broad, membranous appendages on the upper part, which are especially noticeable on the fore-legs; so that the creature while resting has the appearance of a leaf that has been gnawed on both sides by a caterpillar. While the color of the insect varies at different periods of its life, it always more or less resembles a leaf at some stage; when settled on the leaves and eating at them, its body becomes bright green. After death it becomes brown like a dry leaf. The stick insects are common in the tropics, which are the principal habitat of the leaf insects, and are also found in temperate regions, including the United States. The tropical species are the largest, some of them reaching nine or ten inches in length. They are hatched from the egg in a form closely resembling that of their parents, coming into the world with three pairs of legs, which keep their shape with but little, if any, alteration during their entire existence, and which are all walking limbs. At all stages of their life they closely resemble sticks and twigs, either green and growing, or brown and withered, from which they obtain their name. They are also called specters, from their skeleton-like appearance and their slow, stealthy movements. A colony of these insects in the London Zoölogical Gardens is breeding prosperously.

Fort Ancient.—Mr. Warren K. Moorehead gave the American Association an account of his excavations of Fort Ancient, Ohio, and what he found there, in which he more fully elaborated the theory of the history of that work which was indicated in the volume upon it that we have recently reviewed. One of the points of this theory, based on the comparison of the potteries and implements found in and around the fort, and the burials, was that it was a point of contest, or battle-ground, between two races of men. Other questions occupied the author's mind as he considered the subject, and years, he said, might be spent in careful excavation of the graves and cemeteries, and there would still remain sufficient material to engage the attention of antiquaries for a long time to come. "This great inclosure, so rich in facts, so productive of implements that tell us of the every-day life of the ancient people who lived within its walls, may yet reveal to the patient investigator a history that shall go far toward dispelling the darkness that surrounds the origin and movements of ancient men on the American continent." The site has been bought by the State of Ohio, and will be preserved as a State park.

The Spectra of the Metals.—A paper by Prof. Rowland, of Johns Hopkins University, on The Spectra of the Metals, was received by the Physical Section of the British Association as a most important advance in our knowledge. The author had undertaken during the past year the measurement of the wave-lengths of the lines of nearly all the metallic spectra, and had compared them with the solar spectrum, in order to ascertain which metals were certainly present in the sun. The object of the research was primarily to find out what sort of things molecules are, and in what way they vibrate. This can be deduced from the wave-lengths of the light emitted if we can find any relation between these wave-lengths. If the molecules are spheres, we should have a series of bands getting gradually nearer together toward the violet, and representing harmonics of one fundamental vibration. A spheroid or ellipsoid would give a similar crowding, but not so uniformly arranged. The author had worked on a larger scale than in any previous observations, with negatives twenty feet long for the whole spectrum. He looked for and found many indications of the truth of the periodic law, which points to the fact that similar chemical substances have molecules vibrating in a similar manner. As examples, nearly every line in the spectrum of zinc has a corresponding one in that of cadmium; so also with calcium, strontium, and barium, and with potassium, cæsium, and rubidium. In the case of several elements there is a band, consisting of three very bright lines, which it is supposed correspond to vibrations along the three principal axes of the molecule. But the agreement in the spectra of various metals does not extend to all members of the group. For instance, the spectra of beryllium and magnesium do not resemble those of the other alkaline metals. Lockyer supposed a fundamental basic line common to all the elements, but the author found no trace of it. Any line in the solar spectrum which is common to two elements Prof. Rowland considers to be so only by coincidence. Further dispersion would separate the line into two. Some elements give no lines, except in the ultra-violet—boron, for example. Probably most elements have lines beyond the limits of the photographic plate. The author doubts whether the platinum metals and uranium are present in the sun. Among substances not present are antimony, bismuth, arsenic, boron, gold, and nitrogen. On the other hand, many lines in the sun, such as D 3, correspond with no known metal.

Physical Development versus Consumption.—For several years Dr. G. W. Hambleton, President of the London Polytechnic Physical Development Society, has been publishing papers showing how physical development may be employed to counteract consumption. He has given the results of further researches in a communication to the British Association. His theory is that consumption is directly produced by conditions that tend to reduce the breathing capacity below a certain point in proportion to the rest of the body, and that it can both be prevented and recovered from by the adoption of measures based upon that interpretation of its nature. Tables were exhibited showing the measurements of one hundred of the two hundred members of the author's society who have already obtained an increase of chest-growth of one inch and upward. The average increase is a little over an inch and three quarters. A considerable increase was also obtained in range of movement. The increase has taken place in small as well as in large chests, whether the men were tall or short, under or over twenty-one years of age, and with or without gymnastic training. The subjects were engaged in more than fifty different trades and occupations, working in them from eight to twelve hours daily. The variations in chest-girth that took place during the year were also significant. Some of the members of the society were prominent members of the gymnasium, and as such had energetically prepared themselves for certain exercises there. On such occasions he had frequently noted a large decrease of the chest-girth. The girth also decreased when the men were much engaged in extra work, stock-taking, cycling, etc., or when they neglected to follow the directions given them. In fact, the increase or decrease observed was in direct relationship with a corresponding change in the conditions of their surroundings. But it is not only in the ordinary routine of daily life that this relationship between the chest-girth and the conditions to which it is subjected is manifested. In the treatment of consumption the author had obtained increases of from two to three inches and upward. This increase of the chest-girth is accompanied by a corresponding increase of the range of movement and of the vital capacity, and by a change in the type of chest from that of disease to that of health; for happily it could be said that the treatment of disease by this method had been invariably successful. What had been experimentally obtained had been also equally well obtained in the practical application of that research. One part of the investigations confirms the other, and the case as a whole is complete and practicable.

Fatness and its Treatment.—It is declared to be a misconception that fatness is in itself a disease. It only becomes morbid when, by mechanical pressure, fat impedes the functions of the organs, or by weight unduly burdens the body so as to exhaust the strength or make too large a demand on the resources of force and vitality. There is no certainty in trying to prevent fatness by any process of dieting, for "there are many ways of fat-making, and those persons who have a tendency to its production will make fat, however they are fed—in truth, almost as rapidly on one class of diet as on another. There are idiosyncrasies which may, in a limited number of instances, be taken advantage of to check the tendency to form fat, but these specialties of the chemico-nutritive function are by no means common; and, speaking generally, it must be said that, except by starving the body as a whole, fatness can not be prevented." The exceptions to this rule are chiefly such as may be explained on the principle of a special tissue appetite. Thus some persons have a tendency to form muscle in excess, others to build up the nerves; and the last will grow thin while feeding well; and there are, in this way, persons whose specialty it is to make adipose tissue, and they will wax fat even when other parts of the organization are relatively in a condition approaching starvation. These and many other matters have to be taken into account when calculating the probabilities or improbabilities of success in the endeavor to diminish the fatness of any person by a system of dieting. Drugs, except when intelligently directed to some special morbid condition, have just as little influence in the matter.

Influenza and Children's Growth.—A systematic course of observations of the growth in weight of the children in the Deaf-mute Institution at Copenhagen has been kept up for seven years. Among the most striking results is the fact that the principal increase takes place in the fall months. Last fall (1889) the influenza appeared in Copenhagen toward the end of November. Six of the professors of the institution were attacked, while no pronounced cases were developed among the pupils. At the same time, for four weeks after the 23d of November, the weight of the boys increased only two fifths as rapidly as it had done in the corresponding weeks of the previous years, while the girls gained nothing. It is supposed that the vital force that usually went to increase of weight was for this occasion used up in resisting the germs of the disease.

NOTES.

The conclusions expressed by Prof. Key, in the November number of the Monthly, respecting periods of growth in school children, seem to be confirmed by the measurements of Dr. Henry P. Bowditch in the schools of Boston. From these measurements, Dr. Bowditch observed in the National Academy of Sciences, it was shown that the big boys and girls get their growth earlier in life than the small boys and girls. The latter make up their relative proportion, but not till about a year later in life. The same fact was proved regarding height and weight. There was also shown to be a period of what the author called "female superiority," when the girls are the superiors in height and weight of the boys of the same age. This age is from about fourteen to sixteen years.

Experiments are being tried in Germany in making horseshoes of a material the chief constituent of which is paper. It is said to fit to the hoof better than the iron shoe, to be impervious to water, and to grow rough under use, so as to become a safeguard against slipping.

M. Armand Viré has discovered some dozen rocks in the valley of the Lunain, France, covered with smooth furrows running in various directions, which the people there believe to be scratchings of the devil's claws. They were used, it is supposed, during the Quaternary epoch, for finishing off the stone hatchets.

A portable boat has been devised by Colonel Apostoloff, of the Russian army, which may be constructed instantly by making a framework with the lances of the Cossacks and covering with a tarred cloth. Two boats are capable of carrying thirty-six men, with their baggage and arms.

MM. Fremy and Verneuil have continued their experiments in the manufacture of artificial rubies, which attracted attention several years ago, and, improving their processes, have made it successful on a considerable scale. They now obtain crystals weighing a third of a carat. In their later processes they add carbonate of potash to crude alumina, with bichromate of potash for color. The process, with the agitation of fluoride of barium, is continued for a week without interruption, at a temperature of 1350° C. Several times in the course of their experiments they have observed the red crystals of the ruby formed along with the violet and blue crystals of the sapphire. Mineralogy as well as jewelry is likely to profit by these operations, which are destined to cast light upon the coloring of gems.

Painted human bones have been found by Prof. Vasselovski in two prehistoric graves in the Crimea. Such bones had previously been found in three other graves. They are supposed to belong to the original inhabitants of the Crimea, the Cimmerians of Herodotus, who laid their dead on elevated spots till the birds consumed the flesh, and painted the skeletons, when they were bleached, with some mineral pigment. Painted skeletons have also been found in central Asia.

In some informal remarks at the meeting of the American Folk-lore Society, Dr. J. W. Fewkes gave the results of observations among the Zuñi Indians at Pueblo, which go to show how the traditions of the tribe survive in a kind of dramatic representation by dances. He thought that many historical events could be traced by making a careful study of the dances.

The trustees of the American Museum of Natural History have just opened a collection of the woods of the United States, gathered under the direction of Prof. Sargent, editor of Garden and Forest, and presented by Mr. Morris K. Jesup. It is nearly exhaustive, and represents four hundred and twelve species, including nearly all trees that are large enough to be considered of commercial importance. Attached to each species is a small colored map showing over what areas in the United States the wood is found, while near by are water-color drawings of flowers and fruit of the species, in nearly natural size and colors. In another hall are cases of specimens in economic entomology, illustrating the work of insects injurious to forest trees.

The latest attempt to solve the "smoke problem" is the scheme of Mr. Elliott, of London, for condensing the smoke in water and recovering the by-products. The smoke is drawn from the chimney by means of a fan into a tank of water in which revolving stirrers are moving; by these the products of combustion are churned up and arrested and condensed in the water. When the water is fully charged, it is drawn off, and the tank is filled with fresh water. The charged liquor is to be afterward treated, and the by-products due to the combustion of the coal are to be recovered.

According to a paper of Prof. John Trowbridge, the discharge from a Leyden jar is not a single act, but is a series of oscillatory movements back and forth till an equilibrium is reached. The oscillations take place in $\frac{23}{1000000}$ of a second.

A gigantic pendulum—a bronze wire, a hundred and fifteen metres long, with a steel globe weighing ninety kilogrammes at the end—has been suspended in the Eiffel Tower, for the purpose of demonstrating visibly the motion of the earth.

A leprosy commission has been dispatched from England to India, which, after an investigation of one year, is expected to report concerning the desirability or otherwise of encouraging the voluntary partial withdrawal of lepers from among the non-leprous population; of enforcing the complete isolation of all lepers; and of enforcing the isolation of certain lepers. It will also report on the best methods of accomplishing whatever may be decided upon.

The California Museum Association of Sacramento offers a prize of two hundred and fifty dollars for an invention to utilize the rise and fall of the tides, giving not less than three horse-power for six hours; also two hundred and fifty dollars for an inexpensive device to improve the hygienic conditions of the air in rooms. Inventors to retain all rights. Plans should be sent in by April 1, 1891. Full details on the matter can be obtained by addressing J. A. Woodson, president, Sacramento, Cal.

Dr. Charles A. Oliver has described, in the Transactions of the American Ophthalmological Society, a system of tests, and the apparatus required, which he has devised for detecting color-blindness in railway service. The first test consists in matching wools, being a modification of the Holmgren method; the second requires the recognition of squares of bunting in a series of black boxes at one thousand yards distance; and the third is like the second, except that illuminated colored glass is used instead of bunting, and the test is conducted at night. A spectacle-frame is also used in which different glasses can be inserted so as to produce the light effects of various sorts of weather. A number of advantages are claimed for the system.

In a paper in the Society for the Promotion of Agricultural Science, Prof. Manly Miles remarked that the interdependent biological relations of different farm crops and of the soil microbes that find favorable nutritive conditions in the vicinity of their roots appear to be as important factors in farm economy as the chemical constitution of soils and crops, and the conditions of soil that influence these relations are of great practical interest. The applications of science to agriculture will be best promoted by investigations concerning the life histories and relations of these microbes.

OBITUARY NOTES.

The French aëronaut, Eugène Goddard, died at Brussels, November 9th, in the sixty-third year of his age. He was famous for the numerous and daring ascensions which he executed in Europe and America.

Mr. James Croll, LL. D., F. R. S., author of Climate and Time, and other important works in cosmic science, died December 15th, in the seventieth year of his age. He was of humble birth and without scientific training, but "by sheer force of intellect" and by ability and industry he raised himself to a prominent position among scientific thinkers. His Climate and Time has received great attention, and his works on Oceanic Circulation and Stellar Evolution have been widely read. He had been suffering for several years from a painful disease.

DANIEL GARRISON BRINTON.

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FROM FREEDOM TO BONDAGE.*

By HERBERT SPENCER.

OF the many ways in which common-sense inferences about social affairs are flatly contradicted by events (as when measures taken to suppress a book cause increased circulation of it, or as when attempts to prevent usurious rates of interest make the terms harder for the borrower, or as when there is greater difficulty in getting things at the places of production than elsewhere) one of the most curious is the way in which the more things improve the louder become the exclamations about their badness.

In days when the people were without any political power, their subjection was rarely complained of; but after free institutions had so far advanced in England that our political arrangements were envied by continental peoples, the denunciations of aristocratic rule grew gradually stronger, until there came a great widening of the franchise, soon followed by complaints that things were going wrong for want of still further widening. If we trace up the treatment of women from the days of savagedom, when they bore all the burdens and after the men had eaten received such food as remained, up through the middle ages when they served the men at their meals, to our own day when throughout our social arrangements the claims of women are always put first, we see that along with the worst treatment there went the least apparent consciousness that the treatment was bad; while now that they are better treated than ever before, the proclaiming of their grievances daily strengthens: the loudest outcries coming

* Introduction to a Collection of Essays entitled A Plea for Liberty; An Argument against Socialism and Socialistic Legislation. Consisting of essays by various writers. Edited by Dr. Thomas Mackay. New York: D. Appleton & Co., 1891.

from "the paradise of women," America. A century ago, when scarcely a man could be found who was not occasionally intoxicated, and when inability to take one or two bottles of wine brought contempt, no agitation arose against the vice of drunkenness; but now that, in the course of fifty years, the voluntary efforts of temperance societies, joined with more general causes, have produced comparative sobriety, there are vociferous demands for laws to prevent the ruinous effects of the liquor traffic. Similarly again with education. A few generations back, ability to read and write was practically limited to the upper and middle classes, and the suggestion that the rudiments of culture should be given to laborers was never made, or, if made, ridiculed; but when, in the days of our grandfathers, the Sunday-school system, initiated by a few philanthropists, began to spread and was followed by the establishment of day schools, with the result that among the masses those who could read and write were no longer the exceptions, and the demand for cheap literature rapidly increased, there began the cry that the people were perishing for lack of knowledge, and that the State must not simply educate them but must force education upon them.

And so it is, too, with the general state of the population in respect of food, clothing, shelter, and the appliances of life. Leaving out of the comparison early barbaric states, there has been a conspicuous progress from the time when most rustics lived on barley bread, rye bread, and oatmeal, down to our own time when the consumption of white wheaten bread is universal—from the days when coarse jackets reaching to the knees left the legs bare, down to the present day when laboring people, like their employers, have the whole body covered, by two or more layers of clothing—from the old era of single-roomed huts without chimneys, or from the fifteenth century when even an ordinary gentleman's house was commonly without wainscot or plaster on its walls, down to the present century when every cottage has more rooms than one and the houses of artisans usually have several, while all have fireplaces, chimneys, and glazed windows, accompanied mostly by paper-hangings and painted doors; there has been, I say, a conspicuous progress in the condition of the people. And this progress has been still more marked within our own time. Any one who can look back sixty years, when the amount of pauperism was far greater than now and beggars abundant, is struck by the comparative size and finish of the new houses occupied by operatives—by the better dress of workmen, who wear broadcloth on Sundays, and that of servant girls, who vie with their mistresses—by the higher standard of living which leads to a great demand for the best qualities of food by working people: all results of the double change to higher wages and cheaper commodities, and a distribution of taxes which has relieved the lower classes at the expense of the upper classes. He is struck, too, by the contrast between the small space which popular welfare then occupied in public attention, and the large space it now occupies, with the result that outside and inside Parliament, plans to benefit the millions form the leading topics, and every one having means is expected to join in some philanthropic effort. Yet while elevation, mental and physical, of the masses is going on far more rapidly than ever before—while the lowering of the death-rate proves that the average life is less trying, there swells louder and louder the cry that the evils are so great that nothing short of a social revolution can cure them. In presence of obvious improvements, joined with that increase of longevity which even alone yields conclusive proof of general amelioration, it is proclaimed, with increasing vehemence, that things are so bad that society must be pulled to pieces and reorganized on another plan. In this case, then, as in the previous cases instanced, in proportion as the evil decreases the denunciation of it increases; and as fast as natural causes are shown to be powerful there grows up the belief that they are powerless.

Not that the evils to be remedied are small. Let no one suppose that, by emphasizing the above paradox, I wish to make light of the sufferings which most men have to bear. The fates of the great majority have ever been, and doubtless still are, so sad that it is painful to think of them. Unquestionably the existing type of social organization is one which none who care for their kind can contemplate with satisfaction; and unquestionably men's activities accompanying this type are far from being admirable. The strong divisions of rank and the immense inequalities of means, are at variance with that ideal of human relations on which the sympathetic imagination likes to dwell; and the average conduct, under the pressure and excitement of social life as at present carried on, is in sundry respects repulsive. Though the many who revile competition strangely ignore the enormous benefits resulting from it—though they forget that most of all the appliances and products distinguishing civilization from savagery, and making possible the maintenance of a large population on a small area, have been developed by the struggle for existence—though they disregard the fact that while every man, as producer, suffers from the under-bidding of competitors, yet, as consumer, he is immensely advantaged by the cheapening of all he has to buy—though they persist in dwelling on the evils of competition and saying nothing of its benefits; yet it is not to be denied that the evils are great, and form a large set-off from the benefits. The system under which we at present live fosters dishonesty and lying. It prompts adulterations of countless kinds;

it is answerable for the cheap imitations which eventually in many cases thrust the genuine articles out of the market; it leads to the use of short weights and false measures; it introduces bribery, which vitiates most trading relations, from those of the manufacturer and buyer down to those of the shopkeeper and servant; it encourages deception to such an extent that an assistant who can not tell a falsehood with a good face is blamed; and often it gives the conscientious trader the choice between adopting the malpractices of his competitors, or greatly injuring his creditors by bankruptcy. Moreover, the extensive frauds, common throughout the commercial world and daily exposed in law-courts and newspapers, are largely due to the pressure under which competition places the higher industrial classes; and are otherwise due to that lavish expenditure which, as implying success in the commercial struggle, brings honor. With these minor evils must be joined the major one, that the distribution achieved by the system, gives to those who regulate and superintend, a share of the total produce which bears too large a ratio to the share it gives to the actual workers. Let it not be thought, then, that in saying what I have said above, I under-estimate those vices of our competitive system which, thirty years ago, I described and denounced.* But it is not a question of absolute evils; it is a question of relative evils—whether the evils at present suffered are or are not less than the evils which would be suffered under another system—whether efforts for mitigation along the lines thus far followed are not more likely to succeed than efforts along utterly different lines.

This is the question here to be considered. I must be excused for first of all setting forth sundry truths which are, to some at any rate, tolerably familiar, before proceeding to draw inferences which are not so familiar.

Speaking broadly, every man works that he may avoid suffering. Here, remembrance of the pangs of hunger prompts him; and there, he is prompted by the sight of the slave-driver's lash. His immediate dread may be the punishment which physical circumstances will inflict, or may be punishment inflicted by human agency. He must have a master; but the master may be Nature or may be a fellow-man. When he is under the impersonal coercion of Nature, we say that he is free; and when he is under the personal coercion of some one above him, we call him, according to the degree of his dependence, a slave, a serf, or a vassal. Of course I omit the small minority who inherit means: an incidental, and not a necessary, social element. I speak only of the vast majority, both cultured and uncultured, who maintain them-

* See essay on The Morals of Trade.

selves by labor, bodily or mental, and must either exert themselves of their own unconstrained wills, prompted only by thoughts of naturally-resulting evils or benefits, or must exert themselves with constrained wills, prompted by thoughts of evils and benefits artificially resulting.

Men may work together in a society under either of these two forms of control: forms which, though in many cases mingled, are essentially contrasted. Using the word co-operation in its wide sense, and not in that restricted sense now commonly given to it, we may say that social life must be carried on by either voluntary co-operation or compulsory co-operation; or, to use Sir Henry Maine's words, the system must be that of *contract* or that of *status*—that in which the individual is left to do the best he can by his spontaneous efforts and get success or failure according to his efficiency, and that in which he has his appointed place, works under coercive rule, and has his apportioned share of food, clothing, and shelter.

The system of voluntary co-operation is that by which, in civilized societies, industry is now everywhere carried on. Under a simple form we have it on every farm, where the laborers, paid by the farmer himself and taking orders directly from him, are free to stay or go as they please. And of its more complex form an example is yielded by every manufacturing concern, in which, under partners, come clerks and managers, and under these, timekeepers and over-lookers, and under these operatives of different grades. In each of these cases there is an obvious working together, or co-operation, of employer and employed, to obtain in one case a crop and in the other case a manufactured stock. And then, at the same time, there is a far more extensive, though unconscious, co-operation with other workers of all grades throughout the society. For while these particular employers and employed are severally occupied with their special kinds of work, other employers and employed are making other things needed for the carrying on of their lives as well as the lives of all others. This voluntary co-operation, from its simplest to its most complex forms, has the common trait that those concerned work together by consent. There is no one to force terms or to force acceptance. It is perfectly true that in many cases an employer may give, or an employé may accept, with reluctance: circumstances he says compel him. But what are the circumstances? In the one case there are goods ordered, or a contract entered into, which he can not supply or execute without yielding; and in the other case he submits to a wage less than he likes because otherwise he will have no money wherewith to procure food and warmth. The general formula is not—"Do this, or I will make you"; but it is—"Do this, or leave your place and take the consequences."

On the other hand compulsory co-operation is exemplified by an army—not so much by our own army, the service in which is under agreement for a specified period, but in a continental army, raised by conscription. Here, in time of peace the daily duties—cleaning, parade, drill, sentry work, and the rest—and in time of war the various actions of the camp and the battle-field, are done under command, without room for any exercise of choice. Up from the private soldier through the non-commissioned officers and the half-dozen or more grades of commissioned officers, the universal law is absolute obedience from the grade below to the grade above. The sphere of individual will is such only as is allowed by the will of the superior. Breaches of subordination are, according to their gravity, dealt with by deprivation of leave, extra drill, imprisonment, flogging, and, in the last resort, shooting. Instead of the understanding that there must be obedience in respect of specified duties under pain of dismissal, the understanding now is—"Obey in everything ordered under penalty of inflicted suffering and perhaps death."

This form of co-operation, still exemplified in an army, has in days gone by been the form of co-operation throughout the civil population. Everywhere, and at all times, chronic war generates a militant type of structure, not in the body of soldiers only, but throughout the community at large. Practically, while the conflict between societies is actively going on, and fighting is regarded as the only manly occupation, the society is the quiescent army and the army the mobilized society: that part which does not take part in battle, composed of slaves, serfs, women, etc., constituting the commissariat. Naturally, therefore, throughout the mass of inferior individuals constituting the commissariat, there is maintained a system of discipline identical in nature if less elaborate. The fighting body being, under such conditions, the ruling body, and the rest of the community being incapable of resistance, those who control the fighting body will, of course, impose their control upon the non-fighting body; and the *régime* of coercion will be applied to it with such modifications only as the different circumstances involve. Prisoners of war become slaves. Those who were free cultivators before the conquest of their country, become serfs attached to the soil. Petty chiefs become subject to superior chiefs; these smaller lords become vassals to over-lords; and so on up to the highest: the social ranks and powers being of like essential nature with the ranks and powers throughout the military organization. And while for the slaves compulsory co-operation is the unqualified system, a co-operation which is in part compulsory is the system that pervades all grades above. Each man's oath of fealty to his suzerain takes the form—"I am your man."

Throughout Europe, and especially in our own country, this system of compulsory co-operation gradually relaxed in rigor, while the system of voluntary co-operation step by step replaced it. As fast as war ceased to be the business of life, the social structure produced by war and appropriate to it, slowly became qualified by the social structure produced by industrial life and appropriate to it. In proportion as a decreasing part of the community was devoted to offensive and defensive activities, an increasing part became devoted to production and distribution. Growing more numerous, more powerful, and taking refuge in towns where it was less under the power of the militant class, this industrial population carried on its life under the system of voluntary co-operation. Though municipal governments and guild-regulations, partially pervaded by ideas and usages derived from the militant type of society, were in some degree coercive; yet production and distribution were in the main carried on under agreement—alike between buyers and sellers, and between masters and workmen. As fast as these social relations and forms of activity became dominant in urban populations, they influenced the whole community: compulsory co-operation lapsed more and more, through money commutation for services, military and civil; while divisions of rank became less rigid and class-power diminished. Until at length, restraints exercised by incorporated trades have fallen into desuetude, as well as the rule of rank over rank, voluntary co-operation became the universal principle. Purchase and sale became the law for all kinds of services as well as for all kinds of commodities.

The restlessness generated by pressure against the conditions of existence, perpetually prompts the desire to try a new position. Every one knows how long-continued rest in one attitude becomes wearisome—every one has found how even the best easy-chair, at first rejoiced in, becomes after many hours intolerable; and change to a hard seat, previously occupied and rejected, seems for a time to be a great relief. It is the same with incorporated humanity. Having by long struggles emancipated itself from the hard discipline of the ancient *régime*, and having discovered that the new *régime* into which it has grown, though relatively easy, is not without stresses and pains, its impatience with these prompts the wish to try another system; which other system is, in principle if not in appearance, the same as that which during past generations was escaped from with much rejoicing.

For as fast as the *régime* of contract is discarded the *régime* of status is of necessity adopted. As fast as voluntary co-operation is abandoned compulsory co-operation must be substituted. Some kind of organization labor must have; and if it is not that which arises by agreement under free competition, it must be that which is imposed by authority. Unlike in appearance and names as it may be to the old order of slaves and serfs, working under masters, who were coerced by barons, who were themselves vassals of dukes or kings, the new order wished for, constituted by workers under foremen of small groups, overlooked by superintendents, who are subject to higher local managers, who are controlled by superiors of districts, themselves under a central government, must be essentially the same in principle. In one case, as in the other, there must be established grades, and enforced subordination of each grade to the grades above. This is a truth which the communist or the socialist does not dwell upon. Angry with the existing system under which each of us takes care of himself, while all of us see that each has fair play, he thinks how much better it would be for all of us to take care of each of us; and he refrains from thinking of the machinery by which this is to be done. Inevitably, if each is to be cared for by all, then the embodied all must get the means—the necessaries of life. What it gives to each must be taken from the accumulated contributions; and it must therefore require from each his proportion—must tell him how much he has to give to the general stock in the shape of production, that he may have so much in the shape of sustentation. Hence, before he can be provided for, he must put himself under orders, and obey those who say what he shall do, and at what hours, and where; and who give him his share of food, clothing, and shelter. If competition is excluded, and with it buying and selling, there can be no voluntary exchange of so much labor for so much produce; but there must be apportionment of the one to the other by appointed officers. This apportionment must be enforced. Without alternative the work must be done, and without alternative the benefit, whatever it may be, must be accepted. For the worker may not leave his place at will and offer himself elsewhere. Under such a system he can not be accepted elsewhere, save by order of the authorities. And it is manifest that a standing order would forbid employment in one place of an insubordinate member from another place: the system could not be worked if the workers were severally allowed to go or come as they pleased. With corporals and sergeants under them, the captains of industry must carry out the orders of their colonels, and these of their generals, up to the council of the commander-in-chief; and obedience must be required throughout the industrial army as throughout a fighting army. "Do your prescribed duties, and take your apportioned rations," must be the rule of the one as of the other.

"Well, be it so," replies the socialist. "The workers will appoint their own officers, and these will always be subject to criticisms of the mass they regulate. Being thus in fear of public opinion, they will be sure to act judiciously and fairly; or when they do not, will be deposed by the popular vote, local or general. Where will be the grievance of being under superiors, when the superiors themselves are under democratic control?" And in this attractive vision the socialist has full belief.

Iron and brass are simpler things than flesh and blood, and dead wood than living nerve; and a machine constructed of the one works in more definite ways than an organism constructed of the other,—especially when the machine is worked by the inorganic forces of steam or water, while the organism is worked by the forces of living nerve-centers. Manifestly, then, the ways in which the machine will work are much more readily calculable than the ways in which the organism will work. Yet in how few cases does the inventor foresee rightly the actions of his new apparatus! Read the patent-list, and it will be found that not more than one device in fifty turns out to be of any service. Plausible as his scheme seemed to the inventor, one or other hitch prevents the intended operation, and brings out a widely different result from that which he wished.

What, then, shall we say of these schemes which have to do not with dead matters and forces, but with complex living organisms working in ways less readily foreseen, and which involve the co-operation of multitudes of such organisms? Even the units out of which this re-arranged body politic is to be formed are often incomprehensible. Every one is from time to time surprised by others' behavior, and even by the deeds of relatives who are best known to him. Seeing, then, how uncertainly any one can foresee the actions of an individual, how can he with any certainty foresee the operation of a social structure? He proceeds on the assumption that all concerned will judge rightly and act fairly—will think as they ought to think, and act as they ought to act; and he assumes this regardless of the daily experiences which show him that men do neither the one nor the other, and forgetting that the complaints he makes against the existing system show his belief to be that men have neither the wisdom nor the rectitude which his plan requires them to have.

Paper constitutions raise smiles on the faces of those who have observed their results; and paper social systems similarly affect those who have contemplated the available evidence. How little the men who wrought the French revolution and were chiefly concerned in setting up the new governmental apparatus, dreamt that one of the early actions of this apparatus would be to behead them all! How little the men who drew up the American Declaration of Independence and framed the Republic, anticipated that after some generations the legislature would lapse into the hands of wire-pullers; that its doings would turn upon the contests of office-seekers; that political action would be everywhere vitiated by the intrusion of a foreign element holding the balance between parties; that electors, instead of judging for themselves, would habitually be led to the polls in thousands by their "bosses"; and that respectable men would be driven out of public life by the insults and slanders of professional politicians. Nor were there better previsions in those who gave constitutions to the various other states of the New World, in which unnumbered revolutions have shown with wonderful persistence the contrasts between the expected results of political systems and the achieved results. It has been no less thus with proposed systems of social re-organization, so far as they have been tried. Save where celibacy has been insisted on, their history has been everywhere one of disaster; ending with the history of Cabet's Icarian colony lately given by one of its members, Madame Fleury Robinson, in The Open Court—a history of splittings, re-splittings, re-re-splittings, accompanied by numerous individual secessions and final dissolution. And for the failure of such social schemes, as for the failure of the political schemes, there has been one general cause.

Metamorphosis is the universal law, exemplified throughout the Heavens and on the Earth: especially throughout the organic world; and above all in the animal division of it. No creature, save the simplest and most minute, commences its existence in a form like that which it eventually assumes; and in most cases the unlikeness is great—so great that kinship between the first and the last forms would be incredible were it not daily demonstrated in every poultry-yard and every garden. More than this is true. The changes of form are often several: each of them being an apparently complete transformation—egg, larva, pupa, imago, for example. And this universal metamorphosis, displayed alike in the development of a planet and of every seed which germinates on its surface, holds also of societies, whether taken as wholes or in their separate institutions. No one of them ends as it begins; and the difference between its original structure and its ultimate structure is such that, at the outset, change of the one into the other would have seemed incredible. In the rudest tribe the chief, obeyed as leader in war, loses his distinctive position when the fighting is over; and even where continued warfare has produced permanent chieftainship, the chief, building his own hut, getting his own food, making his own implements, differs from others only by his predominant influence. There is no sign that in course of time, by conquests and unions of tribes, and consolidations of clusters so formed with other such clusters, until a nation has been produced, there will originate from the primitive chief, one who, as czar or emperor, surrounded with pomp and ceremony, has despotic power over scores of millions, exercised through hundreds of thousands of soldiers and hundreds of thousands of officials. When the early Christian missionaries, having humble externals and passing self-denying lives, spread over pagan Europe, preaching forgiveness of injuries and the returning of good for evil, no one dreamt that in course of time their representatives would form a vast hierarchy, possessing everywhere a large part of the land, distinguished by the haughtiness of its members grade above grade, ruled by military bishops who led their retainers to battle, and headed by a pope exercising supreme power over kings. So, too, has it been with that very industrial system which many are now so eager to replace. In its original form there was no prophecy of the factory system or kindred organizations of workers. Differing from them only as being the head of his house, the master worked along with his apprentices and a journeyman or two, sharing with them his table and accommodation, and himself selling their joint produce. Only with industrial growth did there come employment of a larger number of assistants and a relinquishment, on the part of the master, of all other business than that of superintendence. And only in the course of recent times did there evolve the organizations under which the labors of hundreds and thousands of men receiving wages, are regulated by various orders of paid officials under a single or multiple head. These originally small, semi-socialistic, groups of producers, like the compound families or house-communities of early ages, slowly dissolved because they could not hold their ground: the larger establishments, with better subdivision of labor, succeeded because they ministered to the wants of society more effectually. But we need not go back through the centuries to trace transformations sufficiently great and unexpected. On the day when £30,000 a year in aid of education was voted as an experiment, the name of idiot would have been given to an opponent who prophesied that in fifty years the sum spent through imperial taxes and local rates would amount to £10,000,000, or who said that the aid to education would be followed by aids to feeding and clothing, or who said that parents and children, alike deprived of all option, would, even if starving, be compelled by fine or imprisonment to conform, and receive that which, with papal assumption, the State calls education. No one, I say, would have dreamt that out of so innocent-looking a germ would have so quickly evolved this tyrannical system, tamely submitted to by people who fancy themselves free.

Thus in social arrangements, as in all other things, change is inevitable. It is foolish to suppose that new institutions set up, will long retain the character given them by those who set them up. Rapidly or slowly they will be transformed into institutions unlike those intended—so unlike as even to be unrecognizable by their devisers. And what, in the case before us, will be the metamorphosis? The answer pointed to by instances above given, and warranted by various analogies, is manifest.

A cardinal trait in all advancing organization is the development of the regulative apparatus. If the parts of a whole are to act together, there must be appliances by which their actions are directed; and in proportion as the whole is large and complex, and has many requirements to be met by many agencies, the directive apparatus must be extensive, elaborate, and powerful. That it is thus with individual organisms needs no saying; and that it must be thus with social organisms is obvious. Beyond the regulative apparatus such as in our own society is required for carrying on national defense and maintaining public order and personal safety, there must, under the *régime* of socialism, be a regulative apparatus everywhere controlling all kinds of production and distribution, and everywhere apportioning the shares of products of each kind required for each locality, each working establishment, each individual. Under our existing voluntary co-operation, with its free contracts and its competition, production and distribution need no official oversight. Demand and supply, and the desire of each man to gain a living by supplying the needs of his fellows, spontaneously evolve that wonderful system whereby a great city has its food daily brought round to all doors or stored at adjacent shops; has clothing for its citizens everywhere at hand in multitudinous varieties; has its houses and furniture and fuel ready made or stocked in each locality; and has mental pabulum from halfpenny papers, hourly hawked round, to weekly shoals of novels, and less abundant books of instruction, furnished without stint for small payments. And throughout the kingdom, production as well as distribution is similarly carried on with the smallest amount of superintendence which proves efficient; while the quantities of the numerous commodities required daily in each locality are adjusted without any other agency than the pursuit of profit. Suppose now that this industrial *régime* of willinghood, acting spontaneously, is replaced by a *régime* of industrial obedience, enforced by public officials. Imagine the vast administration required for that distribution of all commodities to all people in every city, town, and village, which is now effected by traders! Imagine, again, the still more vast administration required for doing all that farmers, manufacturers, and merchants do; having not only its various orders of local superintendents, but its sub-centers and chief centers needed for apportioning the quantities of each thing everywhere needed, and the adjustment of them to the requisite times. Then add the staffs wanted for working mines, railways, roads, canals; the staffs required for conducting the importing and exporting businesses and the administration of mercantile shipping; the staffs required for supplying towns not only with water and gas but with locomotion by tramways, omnibuses, and other vehicles, and for the distribution of power, electric and other. Join with these the existing postal, telegraphic, and telephonic administrations; and finally those of the police and army, by which the dictates of this immense consolidated regulative system are to be everywhere enforced. Imagine all this and then ask what will be the position of the actual workers! Already on the continent, where governmental organizations are more elaborate and coercive than here, there are chronic complaints of the tyranny of bureaucracies—the *hauteur* and brutality of their members. What will these become when not only the more public actions of citizens are controlled, but there is added this far more extensive control of all their respective daily duties? What will happen when the various divisions of this vast army of officials, united by interests common to officialism—the interests of the regulators *versus* those of the regulated—have at their command whatever force is needful to suppress insubordination and act as "saviors of society"? Where will be the actual diggers and miners and smelters and weavers, when those who order and superintend, everywhere arranged class above class, have come, after some generations, to intermarry with those of kindred grades, under feelings such as are operative in existing classes; and when there have been so produced a series of castes rising in superiority; and when all these, having everything in their own power, have arranged modes of living for their own advantage: eventually forming a new aristocracy far more elaborate and better organized than the old? How will the individual worker fare if he is dissatisfied with his treatment—thinks that he has not an adequate share of the products, or has more to do than can rightly be demanded, or wishes to undertake a function for which he feels himself fitted but which is not thought proper for him by his superiors, or desires to make an independent career for himself? This dissatisfied unit in the immense machine will be told he must submit or go. The mildest penalty for disobedience will be industrial excommunication. And if an international organization of labor is formed as proposed, exclusion in one country will mean exclusion in all others—industrial excommunication will mean starvation.

That things must take this course is a conclusion reached not by deduction only, nor only by induction from those experiences of the past instanced above, nor only from consideration of the analogies furnished by organisms of all orders; but it is reached also by observation of cases daily under our eyes. The truth that the regulative structure always tends to increase in power, is illustrated by every established body of men. The history of each learned society, or society for other purpose, shows how the staff, permanent or partially permanent, sways the proceedings and determines the actions of the society with but little resistance, even when most members of the society disapprove: the repugnance to anything like a revolutionary step being ordinarily an efficient deterrent. So is it with joint-stock companies—those owning railways for example. The plans of a board of directors are usually authorized with little or no discussion; and if there is any considerable opposition, this is forthwith crushed by an overwhelming number of proxies sent by those who always support the existing administration. Only when the misconduct is extreme does the resistance of shareholders suffice to displace the ruling body. Nor is it otherwise with societies formed of workingmen and having the interests of labor especially at heart—the Trades Unions. In these, too, the regulative agency becomes all-powerful. Their members, even when they dissent from the policy pursued, habitually yield to the authorities they have set up. As they can not secede without making enemies of their fellow-workmen, and often losing all chance of employment, they succumb. We are shown, too, by the late congress, that already in the general organization of Trades Unions so recently formed, there are complaints of "wire-pullers" and "bosses" and "permanent officials." If, then, this supremacy of the regulators is seen in bodies of quite modern origin, formed of men who have, in many of the cases instanced, unhindered powers of asserting their independence, what will the supremacy of the regulators become in long-established bodies, in bodies which have grown vast and highly organized, and in bodies which, instead of controlling only a small part of the unit's life, control the whole of his life?

Again there will come the rejoinder—"We shall guard against all that. Everybody will be educated; and all, with their eyes constantly open to the abuse of power, will be quick to prevent it." The worth of these expectations would be small even could we not identify the causes which will bring disappointment; for in human affairs the most promising schemes go wrong in ways which no one anticipated. But in this case the going wrong will be necessitated by causes which are conspicuous. The working of institutions is determined by men's characters; and the existing defects in their characters will inevitably bring about the results above indicated. There is no adequate endowment of those sentiments required to prevent the growth of a despotic bureaucracy.

Were it needful to dwell on indirect evidence, much might be made of that furnished by the behavior of the so-called Liberal party—a party which, relinquishing the original conception of a leader as a mouthpiece for a known and accepted policy, thinks itself bound to accept a policy which its leader springs upon it without consent or warning—a party so utterly without the feeling and idea implied by liberalism, as not to resent this trampling on the right of private judgment which constitutes the root of liberalism—nay, a party which vilifies as renegade liberals, those of its members who refuse to surrender their independence! But without occupying space with indirect proofs that the mass of men have not the natures required to check the development of tyrannical officialism, it will suffice to contemplate the direct proofs furnished by those classes among whom the socialistic idea most predominates, and who think themselves most interested in propagating it—the operative classes. These would constitute the great body of socialistic organization, and their characters would determine its nature. What, then, are their characters as displayed in such organizations as they have already formed?

Instead of the selfishness of the employing classes and the selfishness of competition, we are to have the unselfishness of a mutual-aiding system. How far is this unselfishness now shown in the behavior of workingmen to one another? What shall we say to the rules limiting the numbers of new hands admitted into each trade, or to the rules which hinder ascent from inferior classes of workers to superior classes? One does not see in such regulations any of that altruism by which socialism is to be pervaded. Contrariwise, one sees a pursuit of private interests no less keen than among traders. Hence, unless we suppose that men's natures will be suddenly exalted, we must conclude that the pursuit of private interests will sway the doings of all the component classes in a socialistic society.

With passive disregard of others' claims goes active encroachment on them. "Be one of us or we will cut off your means of living," is the usual threat of each Trades Union to outsiders of the same trade. While their members insist on their own freedom to combine and fix the rates at which they will work (as they are perfectly justified in doing), the freedom of those who disagree with them is not only denied but the assertion of it is treated as a crime. Individuals who maintain their rights to make their own contracts are vilified as "blacklegs" and "traitors," and meet with violence which would be merciless were there no legal penalties and no police. Along with this trampling on the liberties of men of their own class, there goes peremptory dictation to the employing class: not prescribed terms and working arrangements only shall be conformed to, but none save those belonging to their body shall be employed—nay, in some cases, there shall be a strike if the employer carries on transactions with trading bodies that give work to non-union men. Here, then, we are variously shown by Trades Unions, or at any rate by the newer Trades Unions, a determination to impose their regulations without regard to the rights of those who are to be coerced. So complete is the inversion of ideas and sentiments that maintenance of these rights is regarded as vicious and trespass upon them as virtuous.*

Along with this aggressiveness in one direction there goes submissiveness in another direction. The coercion of outsiders by unionists is paralleled only by their subjection to their leaders. That they may conquer in the struggle they surrender their individual liberties and individual judgments, and show no resentment however dictatorial may be the rule exercised over them. Everywhere we see such subordination that bodies of workmen unanimously leave their work or return to it as their authorities order them. Nor do they resist when taxed all round to support strikers whose acts they may or may not approve, but instead, ill-treat recalcitrant members of their body who do not subscribe.

The traits thus shown must be operative in any new social organization, and the question to be asked is—What will result from their operation when they are relieved from all restraints? At present the separate bodies of men displaying them are in the midst of a society partially passive, partially antagonistic; are subject to the criticisms and reprobations of an independent press; and are under the control of law, enforced by police. If in these circumstances these bodies habitually take courses which override individual freedom, what will happen when, instead of being only scattered parts of the community, governed by their

* Marvelous are the conclusions men reach when once they desert the simple principle, that each man should be allowed to pursue the objects of life, restrained only by the limits which the similar pursuits of their objects by other men impose. A generation ago we heard loud assertions of "the right to labor," that is, the right to have labor provided; and there are still not a few who think the community bound to find work for each person. Compare this with the doctrine current in France at the time when the monarchical power culminated; namely, that "the right of working is a royal right which the prince can sell and the subjects must buy." This contrast is startling enough; but a contrast still more startling is being provided for us. We now see a resuscitation of the despotic doctrine, differing only by the substitution of Trades Unions for kings. For now that Trades Unions are becoming universal, and each artisan has to pay prescribed moneys to one or another of them, with the alternative of being a non-unionist to whom work is denied by force, it has come to this, that the right to labor is a Trade-Union right, which the Trade Union can sell and the individual worker must buy!

separate sets of regulators, they constitute the whole community, governed by a consolidated system of such regulators, when functionaries of all orders, including those who officer the press, form parts of the regulative organization; and when the law is both enacted and administered by this regulative organization? The fanatical adherents of a social theory are capable of taking any measures, no matter how extreme, for carrying out their views: holding, like the merciless priesthoods of past times, that the end justifies the means. And when a general socialistic organization has been established, the vast, ramified, and consolidated body of those who direct its activities, using without check whatever coercion seems to them needful in the interests of the system (which will practically become their own interests), will have no hesitation in imposing their rigorous rule over the entire lives of the actual workers; until, eventually, there is developed an official oligarchy, with its various grades, exercising a tyranny more gigantic and more terrible than any which the world has seen.

Let me again repudiate an erroneous inference. Any one who supposes that the foregoing argument implies contentment with things as they are, makes a profound mistake. The present social state is transitional, as past social states have been transitional. There will, I hope and believe, come a future social state differing as much from the present as the present differs from the past with its mailed barons and defenseless serfs. In Social Statics, as well as in The Study of Sociology and in Political Institutions, is clearly shown the desire for an organization more conducive to the happiness of men at large than that which exists. My opposition to socialism results from the belief that it would stop the progress to such a higher state and bring back a lower state. Nothing but the slow modification of human nature by the discipline of social life, can produce permanently advantageous changes.

A fundamental error pervading the thinking of nearly all parties, political and social, is that evils admit of immediate and radical remedies. "If you will but do this, the mischief will be prevented." "Adopt my plan and the suffering will disappear." "The corruption will unquestionably be cured by enforcing this measure." Everywhere one meets with beliefs, expressed or implied, of these kinds. They are all ill-founded. It is possible to remove causes which intensify the evils; it is possible to change the evils from one form into another; and it is possible, and very common, to exacerbate the evils by the efforts made to prevent them; but anything like immediate cure is impossible. In the course of thousands of years mankind have, by multiplication, been forced out of that original savage state in which small numbers supported themselves on wild food, into the civilized state in which the food required for supporting great numbers can be got only by continuous labor. The nature required for this last mode of life is widely different from the nature required for the first; and long-continued pains have to be passed through in remolding the one into the other. Misery has necessarily to be borne by a constitution out of harmony with its conditions; and a constitution inherited from primitive men is out of harmony with the conditions imposed on existing men. Hence it is impossible to establish forthwith a satisfactory social state. No such nature as that which has filled Europe with millions of armed men, here eager for conquest and there for revenge—no such nature as that which prompts the nations called Christian to vie with one another in filibustering expeditions all over the world, regardless of the claims of aborigines, while their tens of thousands of priests of the religion of love look on approvingly—no such nature as that which, in dealing with weaker races, goes beyond the primitive rule of life for life, and for one life takes many lives—no such nature, I say, can, by any device, be framed into a harmonious community. The root of all well-ordered social action is a sentiment of justice, which at once insists on personal freedom and is solicitous for the like freedom of others; and there at present exists but a very inadequate amount of this sentiment.

Hence the need for further long continuance of a social discipline which requires each man to carry on his activities with due regard to the like claims of others to carry on their activities; and which, while it insists that he shall have all the benefits his conduct naturally brings, insists also that he shall not saddle on others the evils his conduct naturally brings: unless they freely undertake to bear them. And hence the belief that endeavors to elude this discipline will not only fail, but will bring worse evils than those to be escaped.

It is not, then, chiefly in the interests of the employing classes that socialism is to be resisted, but much more in the interests of the employed classes. In one way or other production must be regulated; and the regulators, in the nature of things, must always be a small class as compared with the actual producers. Under voluntary co-operation as at present carried on, the regulators, pursuing their personal interests, take as large a share of the produce as they can get; but, as we are daily shown by Trades-Union successes, are restrained in the selfish pursuit of their ends. Under that compulsory co-operation which socialism would necessitate, the regulators, pursuing their personal interests with no less selfishness, could not be met by the combined resistance of free workers; and their power, unchecked as now by refusals to work save on prescribed terms, would grow and ramify and consolidate till it became irresistible. The ultimate result, as I have before pointed out, must be a society like that of ancient Peru, dreadful to contemplate, in which the mass of the people, elaborately regimented in groups of 10, 50, 100, 500, and 1,000, ruled by officers of corresponding grades, and tied to their districts, were superintended in their private lives as well as in their industries, and toiled hopelessly for the support of the governmental organization.

A BRIEF HISTORY OF THE OHIO RIVER.

By Prof. JOSEPH F. JAMES, M. Sc.

FAR up in one of the wildest regions of eastern North America rise most of the streams which form the Ohio River. These streams are separated from the head-waters of the Potomac by a spur of the Appalachian Mountains only a few miles wide. This region, in Randolph County, West Virginia, was called, many years ago, and, for aught I can say to the contrary, may still be known as "Canaan." It is a wild, undeveloped tract of thousands of acres, with many deer and bears; surrounded by rugged mountains, abounding in leaping trout-streams, and full of laurel brakes impenetrable alike to man and beast. Within these precincts are the sources of one of the great rivers of the continent.

The picturesque birth of the Ohio River is a fitting prelude to its romantic history. Its physical history is almost that of the continent, for its birth dates back to a time when a large part of eastern North America rose for the last time above the surface of the sea. Centuries ago its valley was the home of the hairy mammoth and the lordly mastodon. In later times it saw the bison in countless herds reflected in its waters. The mound-builders have left some of their most wonderful works within the confines of its valley. Later still, its hills have re-echoed the shouts and battle-cries of Indian and of white; and now the hum of industry and the homes of civilized man fill its valley from end to end. "La belle rivière" it still remains, and to this it might add another epithet, "La méchante rivière" (or the wayward river), because of its astonishing variations in volume of water.

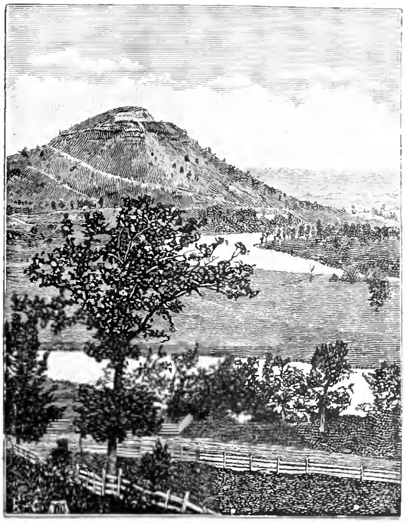
The Ohio River proper results from the union of two streams in the western portion of Pennsylvania. One of these—the Monongahela—rises in that "Canaan" already referred to, and is in its turn formed of two branches, the Cheat and the Tygart's Valley Rivers. These are formed again of minor streams, whose ultimate sources lie along the back-bone or high ridge which separates the sources of the rivers of the Atlantic coast from those of the Mississippi Valley. The Cheat is a wild and romantic stream, particularly at its head-waters, where it tumbles over and around rocks in the wild and reckless exuberance of youth. It abounds with trout, and furnishes scenery well worthy the attention of artist or student of nature.

The Monongahela itself has become somewhat celebrated of late years, because of certain terraces found along its banks, the history of which has been the source of considerable speculation. They are found in the vicinity of Morgantown, W. Va., and are composed of silt, clay, and loam, with a few animal and many plant remains scattered throughout their extent. They vary from 70 to 275 feet above low water in the river, but have an approximate elevation of from 1,045 to 1,065 feet above tide. Evidently produced by the action of water, they are yet too far removed from the present stream to have been formed by its agency, at least in its present condition. An explanation of their origin will be suggested later on in the course of this article.

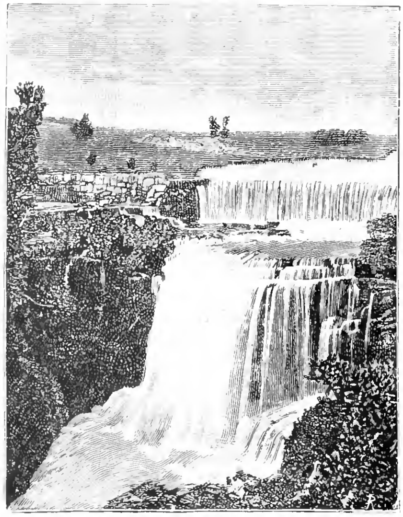
The other branch, which unites with the Monongahela, is the Alleghany. This takes its rise in the northwestern part of Pennsylvania, enters New York State for a short distance, turns south again, and joins its sister stream at Pittsburg. It does not rise in a mountainous country, but in a region comparatively level; and there is every reason to believe at one time in its existence it was tributary to Lake Erie instead of to the Ohio. It is some four hundred miles long, and is navigable for small boats for two hundred and fifty miles from its mouth. It flows through the great oil and gas region of Pennsylvania, a region which gave to the world over 150,000,000 barrels of petroleum. It is from here, too, that has come the gaseous fuel which has changed Pittsburg from the smokiest city of the Nation into one of the cleanest. Pittsburg, besides being a great manufacturing center, is the starting-point for the great coal fleets that supply the cities of Cincinnati, Louisville, and hundreds of others with the fuel taken from the mines of Pennsylvania. From this point begins the Ohio River proper. We may glance now at its history, and trace briefly the vicissitudes through which it has passed from its birth to the present time.

The actual birth of the Ohio River dates from the close of the Carboniferous or Coal era, and the final elevation of the Appalachian chain of mountains. Previous to that time the country through which the river now flows lay upon the borders of the ocean, and in places was lost in the ocean itself. After the land was elevated above the sea-level, the drainage system of the valley was established, and the great river was born.

All streams in the course of their existence go through several phases, which correspond to the features presented by the different parts of their course. The head-waters are swift and roaring torrents, leaping from ledge to ledge, or dashing round and over masses of rock in their wild mountain homes. Lower down the current slackens, some of the impetuosity is lost, but it still glides swiftly over its rocky bed. Still lower down the current becomes slower, the stream broadens out, and the bed loses its rocky and



Ideal view of an Old Unglaciated Country, showing the form assumed by the Eminences when Erosion has proceeded to a great extent. (United States Geological Survey.) (Chamberlin.)



A Country, in contrast with the adjacent Figure, in which the Drainage has been disturbed by Glacial Deposits, and the Streams are beginning to wear new Channels. (Chamberlin.)

rugged character; while as the mouth is approached the current becomes sluggish, broad bottoms appear, a greater width to the stream is apparent, and all signs point to the end of its career. As with the course of a river, so with its life. In early days, before the channel is well defined, it is a foaming torrent. Later on it smooths its bed and becomes more stable in position. As years and centuries pass away, the rougher places are leveled, and the stream then flows placidly in its course over its well-worn, often deeply excavated channel. The Ohio has reached this last stage in its history, for at only a single place in all its course from Pittsburg to its mouth does its channel show signs of a rocky character. The reason for this single exception will soon become clear.

An examination of the geological structure of the country through which the Ohio flows shows none but the extreme end of the valley to be of later age than the Carboniferous. Portions are, indeed, far older; but the area covered by these, though perhaps extensive enough to allow the development of some system of drainage, was never large enough to develop a stream of any great size. None of the tributaries of the river, either from the north or the south, flow through regions more recent than the Carboniferous, with the exception of the lower parts of the Ohio itself and of the Tennessee, which border on the Quaternary. The lowest formation in the valley is the Cincinnati, which is just touched at a single point, and only for a short distance, about twenty miles above the city.

It may be stated, then, that since the close of Carboniferous time the river has flowed mainly in the same channel. The vast antiquity of the river is thus easily established, and the existence of the wide valley, with its broad bottom lands, is readily accounted for. The story of the river during the long period of pre-glacial time would be simple. For ages its waters were probably poured directly into the Gulf of Mexico, an arm of which extended northward into the continent at least as far as the present site of Cairo, Illinois. In later time the Mississippi-Missouri began the formation of a delta, which, gradually extending, has left the Ohio a tributary merely of the mighty "Father of Waters." As ages passed away it smoothed its rocky bed, and cut deeper and deeper between the hills, until at last there came a time in the history of the earth which man has called the "Glacial period." It was an age of intense cold—when a mantle of ice and snow covered all the New England States, New York, part of Pennsylvania, of Ohio, of Indiana, and Illinois, and thence extended northwestward to Dakota and the Rocky Mountain region. When the period was at its height, and the maximum limit of the ice-sheet had been reached, the course of the Ohio River became seriously affected.

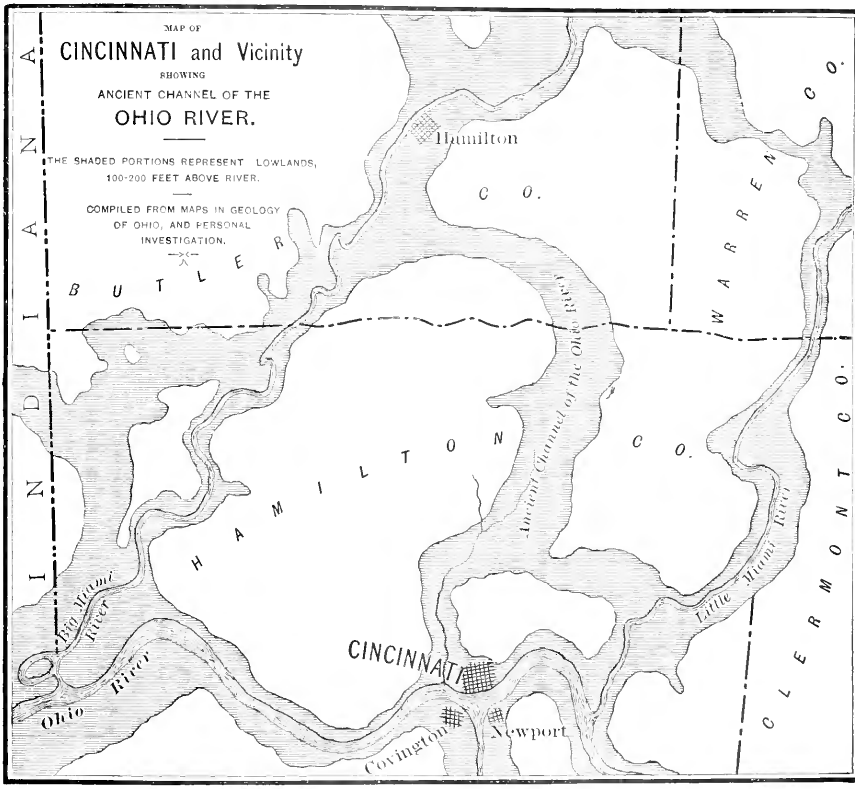
Profs. G. F. Wright and H. Carvill Lewis, Mr. Warren Upham and others, have shown that, at the period of the greatest extension of the ice, a portion of it crossed the Ohio River in the vicinity of Cincinnati, and extended southward for some miles into Kentucky. The course of the river as it now exists was blocked for a distance of probably fifty miles, or from near Point Pleasant, twenty miles above Cincinnati, to the mouth of the Big Miami, thirty miles below.

Investigations into the topography and surface geology of the region about Cincinnati reveal the existence of an ancient channel of the Ohio which divided into two branches.* One was on the eastern, the other on the western side of the city, and the two united just north of the city and continued to Hamilton, twenty-five miles. Here the old stream was joined by what is now the Big Miami, and the united rivers then turned southwestward and

* See a paper by the writer in the Journal of the Cincinnati Society of Natural History, vol. xi, pp. 96–101.

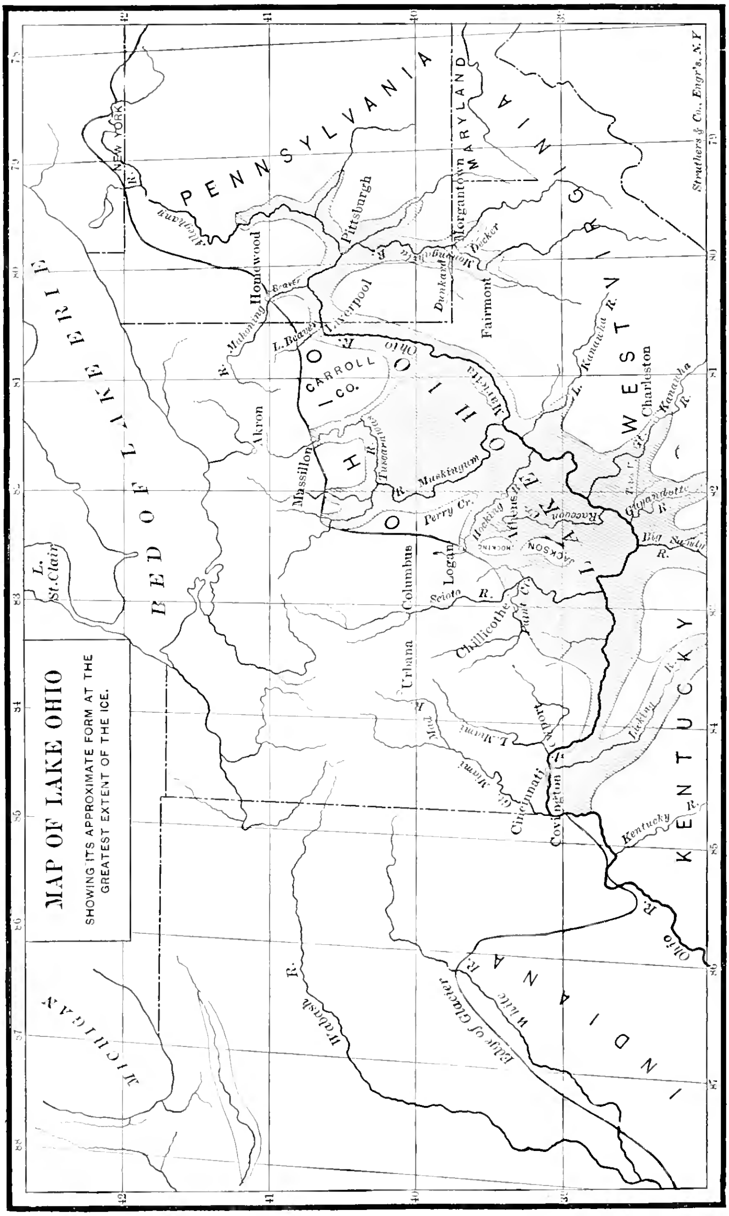
entered the present channel of the Ohio near Lawrenceburg, Indiana.

At the present time the Ohio passes by the city of Cincinnati and follows a channel cut between the hills at a more recent period than the greater portion of its bed. At the time of the existence of the old valley extending north from Cincinnati, a barrier of land extended across from Ohio to Kentucky and barred the way of the river to the west. This was cut down probably



at the time the country was occupied by the glaciers, and as a result we find in the present bed of the stream immense banks of coarse gravel alternately on the Kentucky and on the Ohio side for some miles below Cincinnati, while near the mouth of the Big Miami is another immense deposit which resulted from the melting of the glaciers as they retired northward up that valley.

The consequences of the stoppage of the current of the river are plainly seen. The glaciers creeping down from the north would naturally follow the old channel of the river and prevent its egress to the north, so it was probably during the on-coming of the glaciers that the river began the task of cutting a new channel for itself—the one it now occupies; but when the ice reached and crossed the channel and entered Kentucky, this partly



MAP SHOWING THE EFFECT OF THE GLACIAL DAM AT CINCINNATI (Claypole). (From Transactions of the Edinburgh Geological Society.)

made new way was likewise obstructed. As a result the water rose higher and higher, backing farther and farther up its valley, until its estimated depth varied from three hundred to six hundred feet.

The investigation of this matter was made the subject of a special paper by Prof. E. W. Claypole, and from his pamphlet we glean some interesting facts.

Lake Ohio, as this body of water produced by the ice-dam was called, extended four hundred miles up the valley and was in places two hundred miles broad. Its waters covered the present site of Pittsburg to a depth of three hundred feet. Backing up the Monongahela River, it carved the terraces already mentioned, so that these represent the shores of this ancient lake in the mountains of Pennsylvania. Its northern boundary was formed partly by the ice wall itself and partly by the irregular outline of the high land it could not overflow. A few isolated patches projected as islands above its surface. On the south, long fiords existed in place of the former tributaries, and from the lower end of one of these was the probable outlet for the water. This, however, is still a mooted question, and though it is probable that much found its way through a low pass in the water-shed between the valleys of the Licking and the Kentucky Rivers, it is also likely that a part followed the foot of the ice and reached the Ohio Valley again some thirty or forty miles below the present site of Cincinnati.

How long Lake Ohio was in existence it is, of course, impossible to say. Various facts, however, indicate a life of many hundreds, perhaps thousands of years. So long as the dam existed, Lake Ohio held its own; but, when the ice began its retreat, the fate of the lake was sealed. As year after year the foundations of the dam were weakened, the pressure of the water was with greater and greater difficulty withstood. The heat of summer sapped its strength, but this was again renewed by the winter's cold; but, when the cold of winter was insufficient to supply the waste of summer, the end was really at hand. As Prof. Claypole says: "Possibly the change was gradual and the dam and the lake went gently down together. Possibly, but not probably, this was the case. Far more likely is it that the melting was rapid and that it sapped the strength of the dam faster than it lowered the water. This will be more probable when we consider the immense area to be drained. The catastrophe was then inevitable—the dam broke, and all the accumulated water of Lake Ohio was poured through the gap. Days and even weeks must have passed before it was all gone; but at last its bed was dry. The upper Ohio Valley was free from water, and Lake Ohio had passed away." *

This conflict of ice and water must have been frequently repeated, for the cold of winter would have repaired the damage of the summer; so that year after year, for how long one can not tell, the conflict was renewed. Says Prof. Claypole: "This

* Lake Age in Ohio, p. 16.

period of conflict between the ice and the river must have been a terrible time for the lower Ohio Valley and its inhabitants. At times the river was dry, and at others bank-full and overflowing. The frost of winter by lessening the supply, and the ice-tongue by forming a dam, combined to hold back the water. The sun of summer, by melting the dam, and the pressure of the accumulated water, by bursting it, combined to let off at once the whole of the retained store. Terrible floods of water and ice, laden with stones, gravel, and sand, must have poured down the river, and have swept everything away in their path—trees, animals, and man, if present. . . . To the human dwellers in the Ohio Valley—for we have reason to believe that the valley was in that day tenanted by man—these floods must have proved disastrous in the extreme. It is scarcely likely that they were often forecast. The whole population of the bottom lands must have been repeatedly swept away; and it is far from being unlikely that in these and other similar catastrophes in different parts of the world, which characterized certain stages in the Glacial era, will be found the far-off basis on which rest those traditions of a flood that are found among almost all savage nations, especially in the north temperate zone."

So there finally came a time when the Ohio Valley was no longer blocked by ice. But, when this time came, the *débris* from the melting glaciers had filled up the previously northward trending channel, while the long-continued floods had cut a new channel along the southern border of the ice as far as the mouth of the Big Miami. Thus was its ancient bed deserted forever, and was left to be occupied by insignificant streams, or else remained high and dry above the reach of any flood of future years.

The city of Louisville stands upon a deserted portion of the Ohio River channel also. It is in front of this city that the celebrated Falls of the Ohio are found. Here the river rushes over a rocky bottom, of itself indicative of a new channel, while on either side are wide stretches of sand or gravel, or low-lying plains through which the river formerly flowed. A late writer in one of the scientific magazines * states that evidence points to the fact that in pre-glacial times the Ohio River divided above the city, one branch flowing on the north and another on the south of an island, the two uniting again below the city. Well-borings show the rock in some places to be one hundred and fifty feet or more below the present surface, and what are now insignificant streams were once large enough to carve valleys half a mile wide and many feet in depth. Where was once the island, are now the falls. The ancient channels are filled with *débris*, and the new channel is a shallow rock cut, excavated since the close of the great Ice age.

* John Bryson, in American Geologist, March, 1890.

A physical history of the Ohio River would not be complete without a mention of the great variation in volume it presents, and some mention of the probable causes. Nothing is definitely known of its fluctuations during the prehistoric period, or indeed previous to 1832. It is true there are traditions of great floods in the river as far back as 1774. In 1787 there was a flood which some authors state reached one hundred and twelve feet. In 1792 there was another, reaching the height of sixty feet. The flood of 1832, of which there is authentic record, attained a height of sixty-four feet three inches. There were, up to 1883, twelve floods which reached or exceeded fifty feet. In that year (1883) the water reached a height of sixty-six feet four inches; and this was exceeded the following year by a volume of water which marked upon the gauge at the Cincinnati Water-Works seventy-one feet, three fourths of an inch. During the year 1890 the water twice reached a depth exceeding fifty feet.

Contrast these great floods with the extreme low water sometimes experienced. Five times during fifty years has the water sunk so low as to leave but three feet in the channel. The lowest ever known was in September, 1881, when the records show that twenty-three inches of water were found where three years later there were seventy-one feet. In October, 1887, it was also very low, there then being but two feet eight inches in the channel. At that time the river in front of Cincinnati showed its hidden dangers as scarcely ever before. A boy four feet high might have waded across without wetting his suspender-buttons. "Ugly-looking black bowlders, long, narrow, jagged reefs of moss- and slime-covered rocks and hillocks of gravel uplift their heads three, four, and five feet above the surface of the stream, all along the channel between the railroad and suspension bridges, while the big bar at the mouth of the Licking thrusts itself sheer across the river to within a hundred feet of the Ohio edge, at the foot of Walnut Street. One pebbled and coal-strewn reef, between Walnut and Vine Streets, is exposed for over two hundred feet, and it can be reached by wading from either shore. A sunken barge, which for years has been concealed from sight by the waters, is now wholly exposed, and its skeleton is visible from keel to gunwales, and stem to stern." *

The cause of such fluctuations is not far to seek. The destruction of forests about the head-waters of the tributaries, large and small, prevents the conservation of the water which falls in a rainy season. It rushes in torrents down the denuded hills and mountains, and is gone in a few days. A smaller amount of rain than the average, and the river becomes abnormally low. Abundant precipitation, on the other hand, combined with such con-

* Local paper, October 27, 1887.

ditions as cause heavy snows to be melted suddenly, together with the absence of forests which tend to absorb moisture and to give it out but slowly, produce disastrous floods, such as have so frequently occurred. That there is any effectual remedy for the floods can scarcely be maintained; that their violence can be mitigated, the adherents of reforesting devoutly believe; and that the great dearth of water can be largely prevented by allowing the hills to become clothed again with forests, and the springs give out their stores perennially instead of drying up in seasons of drought, all must admit. But the problems of a great river are not worked out in a few years, any more than its own history has been. Time is necessary for all things. We firmly believe that man will in the end find a cure for the evils of drought and flood to which the mighty Ohio has been subject since civilized man has planted himself upon her hilly shores.

STREET-CLEANING IN LARGE CITIES.

By General EMMONS CLARK.

ALTHOUGH it is an unquestionable fact that cleanliness of the streets is necessary to the health and comfort of the people, few, if any, of the large American cities have as yet satisfactorily accomplished this important sanitary object. European cities have generally been more successful in this particular, and their success is due mainly to their earlier attention to sanitary subjects, to their more arbitrary methods of enforcing police and sanitary regulations, and to the comparative absence of political and personal influences in their municipal governments. A difference is noticeable in the cleanliness of the streets of American cities, which may be attributed to the great disparity in the character and condition of their population, and the variety of plans upon which the streets are laid out, and the building blocks or squares are constructed. In those cities and parts of cities where the people of the laboring class and the poor are crowded in tenement-houses, and where a considerable part of the population is foreign-born and from countries where personal and public cleanliness have not been enforced by proper police regulations, it is no trifling task to secure cleanliness of the streets; but this desirable result is obtainable with comparative ease in those cities whose founders provided lanes or alleys in the rear of all dwellings, through which house refuse can be removed without any use of the public streets except for its transportation in carts to places of deposit.

New York, from its insular position, from its large foreign-born population, from the crowded condition of a considerable part of its people in tenement-houses, and from its peculiar street and block construction, whereby it is necessary to remove ashes, garbage, and house refuse through a front entrance to carts in the public street, affords an example of the worst possible conditions for street cleanliness. But the more fortunate towns are not entirely exempt from the difficulties and embarrassments which have for a long period surrounded this subject in New York; and, although they may be interested in a less degree in the solution of this great sanitary and social problem, it will be observed that the history of street-cleaning in New York during the past twenty-five years is not uninstructive, and that the improved methods necessary in the metropolis are more or less applicable to all large American cities.

During the past twenty-five years the people of New York have earnestly demanded cleanliness of the streets; the press has echoed public opinion by a vigorous censure of the officials responsible for their filthy condition, and the sanitary authorities have urged from time to time an improvement in this part of the municipal service, as necessary to the public health and comfort. When the Metropolitan Board of Health was organized in March, 1866, it inherited from the city inspector the duty of enforcing an existing contract for cleaning the streets and removing the ashes and garbage of the city. The board made an earnest effort to perform its duty; charges of inefficient and unsatisfactory service and breach of contract were frequently made against the contractors; voluminous testimony was taken and counsel were heard, but without the desired results. In answer to the testimony of sanitary inspectors as to the condition of the streets, the contractors were always able to produce abundant evidence from their employés that the streets had been thoroughly cleaned in accordance with the provisions of their contract; and they also claimed that any just cause of complaint was due to the non-enforcement by the police of the laws and sanitary ordinances designed, directly or indirectly, to aid and facilitate their important work.

The hearings of the street-cleaning contractors by the Metropolitan Board of Health demonstrated that cleanliness of the streets is comparative and relative, and a subject upon which men entertain different opinions. A dwelling which a good housewife declares is filthy and intolerable, another housekeeper, less tidy, industrious, and exacting, will pronounce cleanly and satisfactory; so the contractors insisted that the streets of New York were clean, or "thoroughly cleaned," while the board and its officers were firm in the belief that they were dirty, detrimental to health, and discreditable to the city. It was also demonstrated at these hearings that it is hardly possible to draw a contract that will secure clean streets without giving entire and unquestionable power to the city authorities to revoke and cancel the same at pleasure, and that with such a condition no responsible contractor would undertake the work and invest the large amount of money necessary for its performance. The importunity of the Board of Health, and its dissatisfaction with the condition of the streets, finally led to a sale of the street-cleaning contract to the Hon. James R. Whiting, a prominent leader in all movements for municipal reform at that period. Great hopes and expectations were entertained by all good citizens that New York would soon rejoice in clean streets, but they were doomed to disappointment, for no permanent improvement was visible. The opinion of all interested, officially or otherwise, was quite unanimous at last that street-cleaning by contract was a hopeless failure; and there was a general approval of the act of the Legislature of 1872, imposing temporarily upon the Police Department the duty of cleaning the streets and removing the ashes and garbage of the city.

The reasons for permanently conferring this power and duty upon the Police Department in the new city charter of 1873 were, first, that the commission was non-partisan, the two political parties being equally represented; and, second, that the department would strictly enforce the laws of the city and sanitary ordinances in respect to the streets and the care and disposal of ashes and garbage, and thereby remove an alleged cause of the failure of street-cleaning by contract. Although the Police Board was in one sense non-partisan, it soon appeared that both parties were clamoring for appointments and political patronage under the Bureau of Street-cleaning with a power and persistence almost irresistible and not always resisted. Nor was there any considerable improvement in the enforcement of the laws and sanitary ordinances in respect to the streets and the care and removal of ashes and garbage. The police force of New York, in physique, intelligence, and bravery, in the detection and prevention of crime, and in the protection of life and property, is certainly equal to any in the world; but for a proper and thorough enforcement of ordinances and regulations, trifling in detail but important in the aggregate, which concern and are necessary to the comfort of the people, it has never been distinguished. The streets of New York under the police *régime* were certainly as clean, and the removal of the ashes and garbage as well done, as at any previous or subsequent period, and at less expense; but the department did not satisfy the public or the press. A change was earnestly and imperatively demanded, and in 1881 the Legislature created a Department of Street-cleaning with a single head and with ample power for its important purposes. Appropriations for this department have increased from year to year, until the enormous sum of $1,787,774.51 was estimated by the commissioner as necessary for the year 1891, and $1,584,250 was the amount appropriated; changes in the chief officers and employés have been made; various methods and devices have been adopted and tried; but the fact remains and is universally recognized that the streets are unclean. Some attribute their condition to insufficient appropriations; others to the inefficiency and incapacity of those intrusted with the work; others to political influences and to the use of its offices and appointments as political patronage; and others to the system and methods employed in conducting the details of the business. But, whatever the cause, the cry is universal, *Is there no remedy or relief?*

It is confidently asserted that none of the different plans proposed for cleaning the streets, nor an appropriation for that purpose double the present amount, nor a Commissioner of Street-cleaning of ideal business ability, fidelity, and integrity, can give New York clean streets, so long as householders and housekeepers sweep or throw their dust, dirt, ashes, garbage, or refuse, or any part of such material, into the streets, or allow anything to escape from their garbage receptacles upon the sidewalk or upon the street, nor so long as carts conveying dirt and refuse are allowed to drop any part of their contents on the streets. A walk in the principal streets and avenues from seven to nine o'clock in the morning will convince the observer that, whatever the shortcomings of the Street-cleaning Department, storekeepers and housekeepers are primarily and incidentally responsible for dirty streets by allowing their employés to sweep into the streets the dust of their houses or stores, and the dirt and refuse found upon the sidewalk. If the walk is extended to the tenement-house districts at any hour of the day, it will be noticed that it is quite the custom to throw ashes and garbage into the streets, and to allow these materials to escape into the street or upon the sidewalk from insufficient, improper, or overflowing receptacles. It will also be noticed that, soon after a street has been cleaned, it is again defiled by the refuse and garbage from the neighboring buildings, and that the carts which transport street dirt, ashes, and garbage, sand for new buildings, earth from cellar excavations, and the dust and dirt from buildings torn down, scatter some part of their contents into the street as they proceed to their destination. A student of the problem of street-cleaning has only to make the above observations to learn the primary cause of dirty streets in New York, and that, without a thorough reform in this particular, relief is well-nigh hopeless. This simple solution of the problem is only the application to the streets of the familiar rules which govern every well-regulated household. Can a house be clean if the members of the family throw waste paper and other refuse on the floors, and ignore the waste-basket and the cuspidore; and how many times a day must the floors of the house be swept, if such a practice is tolerated?

It being absolutely necessary to the proper cleanliness of the streets that no dust, dirt, refuse, ashes, or garbage should be swept or thrown into the streets or upon the sidewalks, or allowed to escape thereon from ash and garbage receptacles or from carts, a thorough reform must be secured in this particular, and by the following means:

1. The education of the entire population of the city on this subject. All desire clean streets, and an appeal to the common sense and public spirit of the people will be successful. A plain and simple circular from an official source should be placed in the hands of each householder and storekeeper, and of each family in tenement-houses, to the effect that every particle of dust, dirt, ashes, garbage, and refuse should be placed in the garbage receptacles, and that the sidewalk should not be swept into the street, but the dust and paper thereon should be carefully gathered and placed in the garbage receptacles of the stores or houses. Such a circular would be disregarded by some, and all such should be personally warned by an officer of police against the continuance of the practice. Owners of carts conveying dirt, ashes, garbage, manure, or any refuse, should be notified that their carts must be absolutely tight and properly covered, and that the escape into the street of any part of the contents, however trifling, is a violation of the sanitary ordinances, which will be officially noticed by the police. In a very few months the people would thoroughly understand the importance of this subject, and few would overlook or violate regulations so reasonable and proper.

2. When proper notice and warning fail to prevent throwing, sweeping, or allowing the escape into the streets or upon the sidewalk of any dirt, ashes, garbage, or other refuse, the vigorous enforcement of proper sanitary ordinances becomes necessary. It should be made a part of the duty of every police officer on patrol to arrest any one violating such ordinances, and to ascertain who is guilty of any violation in the absence of an officer; and, for any neglect of such duty, officers should be held to as rigid accountability by their superiors as for failure to arrest or detect offenders against the laws concerning life and property. In many European cities the police are so active and vigilant in enforcing sanitary laws and ordinances of this character that the streets are models of cleanliness, and their condition materially promotes the health, comfort, and happiness of the people. To make the action of the police effective, the hearty co-operation of the courts

is necessary, and police justices must promptly punish offenders against the cleanliness of the streets, and severely, too, in case they are repeated. With proper action and co-operation of police officers and police justices, the great and most important obstacle to clean streets in New York can be removed.

When this is accomplished, the following will be necessary to entirely secure the desired object:

1. The laws and sanitary ordinances should be amplified and extended, if necessary, to cover minutely all subjects incidental and necessary to clean streets. Such laws and ordinances should be so broad, plain, and explicit that every citizen would know his duty in the premises, that every police officer would be certain when it was proper to make an arrest for violations, and that no police justice could fail to punish upon proper evidence.

2. The ash and garbage receptacles, in which the refuse of buildings and the sweepings from the sidewalk should be carefully placed, should be well made of galvanized iron, of style and size prescribed by ordinance, and they should be portable, absolutely tight, with covers, and the covers should not be removed except when necessary. These receptacles should be placed for removal in the areas within the stoop lines, or in some other convenient place, but never on the sidewalks; and rag-pickers and scavengers should not be allowed to disturb their contents. The ashes and garbage should be removed daily at a fixed and regular hour from every building, in absolutely tight carts, of size and style prescribed by ordinance, with covers so arranged that no part of the contents can escape. Carts for the transportation of street or cellar dirt, manure or other refuse, should also be of uniform size and style, tight and covered, and specially constructed and adapted to their respective purposes.

Public cremation of garbage, or its utilization by some of the known methods, should be introduced in New York without delay. Proper buildings for this purpose should be constructed upon the water front, conveniently located in different parts of the city. In many cities in this country the different processes are used for this purpose with satisfactory results. It is several years since the New York Board of Health demonstrated that refuse animal matter could be safely and inoffensively utilized within the city limits, and the metropolis should not be last to avail itself of improved methods for disposing of its garbage. When arrangements are made for the public cremation or utilization of garbage, the ashes and garbage should be placed in separate receptacles, and should be removed separately, the ashes being disposed of for filling sunken lots, redeeming marshy ground, and making new land in the city and vicinity. For a long period in the future, street dirt, and ashes free from garbage, will be demanded for these purposes; the expense of removal would be trifling, and possibly at times could be done without cost to the city; and the improvements made by this means would abate the serious nuisances caused by stagnant water, and by wet and marshy lands, and add to the taxable property of the city. The harbor of New York would also be relieved from the dangers incident to the dumping of ashes and garbage in the neighboring waters, and the adjacent shores would be spared from the offensive nuisance caused by such a primitive and obnoxious practice. The removal and disposal of ashes and garbage should be done by contract, as the details of the work can be minutely specified. As a general rule, municipal work should be done by contract, as the direct employment of men by public officials, and the ownership of carts, horses, and stables by the corporation, are likely to lead, directly or indirectly, to abuses, personal or political, and private enterprise can satisfactorily accomplish nearly all public work at reduced expense to the city.

3. The city should be divided into districts of such size that one man would be able to sweep the streets of his district and keep them clean at all times. Nothing being swept or thrown into the street, one man would be able to keep in good order a considerable territory. To every twenty-five or thirty districts there should be an inspector or foreman, to note the service of the men, their efficiency, capacity, and faithfulness, and the character and result of their work. To these inspectors or foremen the sweepers in charge of districts should be directly responsible for the cleanly condition of the streets in their respective territories, and the inspectors should be responsible to a general superintendent under the Commissioner of Street-cleaning. The inspectors, as well as the sweepers, should be known to the citizens of their districts by a badge or uniform; and they should aid the police, by information and otherwise, in the enforcement of the laws and ordinances relating to the streets and their cleanliness. The inspectors should be men of the discretion and executive capacity necessary to their office; and the sweepers should be able-bodied, industrious, and temperate men, their qualifications to be tested by a fair trial, and their places secure during good service and behavior. Both inspectors and sweepers should be paid by the month, thereby elevating their respective positions above that of the day laborer, and making this employment desirable on account of its continuity and permanence.

4. The cleaning of streets and the removal of ashes and garbage should be conducted on strictly business principles, and can never be successful or satisfactory unless exempted from personal and political influences. The commissioner at the head of the department and all officers and employés, including street-

sweepers in charge of districts, should be selected solely because of their fitness for their respective duties, and should not be removed except for good and sufficient cause. The methods of the successful merchant, banker, and manufacturer, especially in respect to all employés, are necessary to the economical and satisfactory conduct of any public business; and whoever attempts to clean the streets of New York by any other theory or practice is certain to add another to the many notable failures of the past twenty-five years.

It is believed that with the adoption of the measures and methods above indicated, and strict adherence to the same, with fair executive business ability at the head of the Department of Street-cleaning, the streets of New York can be made as clean as those of London, Paris, or Berlin. From the city statistics it appears that the expense of cleaning the streets and removing the ashes and garbage of the city has increased more rapidly than the population, and that the expense was considerably less comparatively while the business was conducted by the Police Department than at any time since. As there has been no appreciable improvement in the condition of the streets in respect to cleanliness, it may fairly be concluded that the increased appropriations have not produced correspondingly improved results. It is also a reasonable conclusion that, with the exercise and use of business and common-sense methods, the entire cost of keeping the streets of New York clean, and carefully and satisfactorily disposing of its ashes and garbage, should not for a long period exceed the average appropriation of the last five years.

TRAINING FOR CHARACTER.

By Prof. HENRI MARION.

I PURPOSE to study now the movements of the child at the earliest age, and on the present occasion, particularly, the appearance and first steps of the growth of the will. In previous lectures we have witnessed the awakening of emotions in the child.* We have seen its perceptive faculties developing, new

* This lecture is a part of M. Marion's course on the science of education, delivered at the Literary Faculty of Paris. The lecturer's special subject in 1889 was the psychology of the child, and the present lecture was the tenth of the year. Having in previous years treated of education in general, its objects and means, of the great biological, psychological, and moral laws which rule in it, and of the great departments comprehended in it, M. Marion finally comes to the connected subject of the psychical development of the child, attending first to the description of it as it takes place in fact and spontaneously, but pointing out, as he goes, what it ought to be, how it should be directed, and how it is often disturbed.

and more complex sensations gradually modifying its simple and ingenuous egoism; and sympathy appearing and rising out of self-love, and transforming it as would a ferment. The child's social nature breaks out long before the end of the first year; it begins by beaming on the nurse and the mother, and then the child smiles at all pleasant and kindly faces. Play, which begins from this time to hold a large place in its life, appears to us in its origin as an essentially social pleasure. At the same time with the affectionate feelings we see arise those of a contrary character, like jealousy, which St. Augustine fixed in the sixth month.

Feelings and passions of a higher order are attributed by some writers to children of this age—the taste for the beautiful, for example. Some would give it to the child at the breast, with reason, if infants' admiration for bright lights and vivid colors is a taste for the beautiful. While this tendency is common to children with many animals, we have a right to see in it a nascent æsthetic feeling. M. Victor Egger has described a case of musical enthusiasm in a child less than six months old. "Lying on a bed, its nurse having already excited it by playing with it, the Marseillaise was sung to it (in a man's voice). It listened, looked up, with throbbing mouth and throat, throwing its arms out from time to time. In the midst of the song it uttered a single sharp cry that almost frightened us. During all this time it exhibited an intense, joyous emotion, but too deep for infantine joy. It might be said that it put itself in unison with what it heard. The song was not repeated. The child's excitement was too great." Whether enthusiasm or not, there was certainly more than a simple sensation in the emotion thus described. It is very certain that a child of that age should be spared such an intoxication, which could not be repeated many times without grave prejudice to the firmness of its nerves and its psychical equilibrium.

I have not perceived at the period we are considering anything resembling the moral feeling which Mr. Darwin and M. B. Perez believe they have found in the nursling; it appears later, largely as a fruit of education. Associations of agreeable or disagreeable ideas which the infant is susceptible of from its first months should not be confounded with rational feelings, like those of order and justice and right and duty.

The movements are next to receive our attention; they are the only possible signs of what is going on in the child. Its affective sensations, its representative sensations, its feelings—all the phenomena of its psychic life which we have so far studied—are apparent to us only through their motive manifestations. But what we have been able to say in passing of such and such movements as expressions of consciousness is not enough. The motions deserve a special study in themselves and for themselves, in view of their psychological significance, which is immense, especially when it is considered in connection with their intimate relation to voluntary energy. We shall consider, first, in general, the psychological value of the movements. It has already been thought worthy of remark that movements, or muscular contractions, translate the interior life and give it outward radiance. The obscurity of the fact is relieved if we suppose, with contemporary physiology, that thoughts and feelings, as facts of consciousness, while not undoubtedly reducible to simple movements, are nevertheless based on incipient or asserted movements. On the other hand, M. Féré has shown that all sensation is accompanied by an augmentation or disengagement of muscular force. The force and quality of motive manifestations are undeniably signs of psychical dispositions, either permanent or accidental. We all know that a weak and indecisive step, halting speech, slowness in eating, the physical tendency to dawdle and take twice as long as it needs to do anything, betray in children a general mental, corresponding with the organic inertness. The quality of the habitual motions, as revealed by the attitude, the walk, the play of the features, and the writing are certain signs of the character. While we may be mistaken through inexperience or want of attention, or of method in the interpretation of them, their value to a skilled observer can not be disputed.

Motion, strong, various, fruitful, which delights in itself and enjoys the effort it calls out, is agreeable when there is a superabundance of life, when it sets to work reserves of energy which it has not exhausted. The diversities of our tastes come in a large degree from this. What is beyond the capacity of some, and seems impossible or insupportable to them, charms others, and seems like play to them. There is a profound analogy between being fond of action and the physical, and having movement in the mind and force in the character; but it does not extend to identity.

Besides interpreting the moral condition, motions act upon it in return. This reciprocal influence of movements on states of consciousness is another law of general psychology, of which education should not lose sight for an instant. Not only do what we feel, think, and wish determine our motions and acts, but, inversely, the motions and acts which become habitual, even those which were involuntary in the beginning, determine, to a greater or less extent, in time our ways of feeling, thinking, and wishing. The recurrent action of attitudes, gestures, and acts on the moral condition was pointed out long since by physiognomy. The fact, now trite, that, by giving a certain position to the limbs of a hypnotized person, we put him into a corresponding psychical state, is only an extreme case of this law.

The plasticity of the child is hardly less. By causing it to perform a certain motion and habitually preventing it from making the opposite one, we act in a wonderful degree on its feelings and ideas. Is not making it talk, eat, and move in a more lively way a means of shaking off the inertness of which we just spoke? Hence the possibility of that moral training, which should not be confounded with moral education proper, for it is in one sense the opposite, but which is, nevertheless, not unrelated to it; for there is mechanism, one part of training, at the beginning in all education. It is thus important to study the motions of the little child—first, in order to interpret them correctly as signs, and thereby to read in its consciousness; and, second, to know how to regulate them practically, to favor or repress them according to circumstances, and in this way to act upon the child's character. Let us try, then, to retrace in outline the progress of the faculty of motion in the child till it learns how to walk, dwelling preferably upon the movements the more direct relation of which with the will gives them a special importance. The general truth prevails through the whole subject that motions which become voluntary begin by not being so; that intentional activity, the nascent will, does but gain possession of acts which were at first not willed. We are about to inquire how this takes place.

Involuntary motions appear to be of four kinds—automatic, reflex, instinctive, and imitative. The motions which I call automatic are not inspired or guided by any representation, but proceed exclusively from the energy accumulated from nutrition in the nervous centers. They occur when that energy is disengaged outwardly by the motor nerves without peripheric excitation of the sensitive nerves, and of course without a mental representation, of which the subject is not yet capable. These uncoördinated movements, including motions before and just after birth, the first motions of the eyelids, eyes, hands, arms, and legs, and all sorts of grimaces, have in themselves but little psychological interest; but they are the ones of which the will gains the most complete possession. The more indeterminate and characterless they are in their origin, the more conscious energy, awaking in them, will be able to make them its own. The case is different with the motions of the next two categories; regulated and limited by nature, the will will never absolutely dispose of them or resist them without difficulty. It would be no small effort for it to prevent reflex actions and contend against the instincts.

The reflexes are motions which are produced instantaneously and mechanically after certain peripheral impressions; of such is sneezing, the first act of the infant in coming into the world, and coughing. Although they fall more or less under consciousness, in that it is informed of them as they occur or immediately afterward, they are not produced by mental representations, nor are they in any degree at first dependent on the will. By its inevitable and mechanical character, the reflex is the contrary of the voluntary act. Yet we may say that it also is after its way a kind of matter for the will. One of the first exercises imposed by education, one of its most laborious apprenticeships, is to control the reflexes and prevent their being produced. Except for the little that the will may gain upon them, or rather upon the conditions under which they are produced, the reflexes remain substantially the same through life, with the difference, which Preyer seems to have well established, that they are slower in the new-born child than they afterward become.

The instinctive motions resemble the reflexes; they have to a certain point their mechanical character, and are produced only as in consequence of certain determined impressions. Thus, the young chick does not perform the motion of scratching on the carpet, but begins it at once on the gravel walk, as if the feeling of grains of sand was necessary and enough to set the mechanism in motion. But there is a great difference between instinct and the reflex; it is not only that instinct is more complicated and its complex motion is composed of co-ordinated movements; but it is connected with a mental disposition, and is dependent on a psychical representation and tendency, or an image and a feeling.

Some philosophers, reserving the name of instinct for the remarkable industries of some species of animals, like bees and the beaver, deny that man has instincts. But how can we dispute that true and indestructible instincts preside over the functions by which individual life and the life of the species are preserved? The truth is that, while instinct is all with certain animals, with others, more perfectible and higher in the scale by that fact, a very large part is left to the intelligent activity that can adapt itself to circumstances. This is at the maximum in man; and in the adult and cultivated man of the higher races the part of mechanism is reduced very nearly to nothing. But in the child instinct exercises all its rights, till education deranges and modifies it. The instinctive character—that is, partly psychical and not purely reflexive—of the movements composing the action of sucking, appears by the fact that the hungry child will suck at his finger as well as at the breast, while, if he is not hungry, he will refuse even the breast. It is also by instinct that he laughs when we excite him by playing with him, or even by tickling him, for, if he is in a bad humor or a stranger tries the experiment, he may cry instead of laugh. The instinctive reaction depends essentially on the psychic condition at the moment. Nevertheless, this does not prevent instinct being a hereditary mechanism, over which the will has directly very little influence. It can affect it only by disposing at its desire, when it can, the circumstances that call the instinct into exercise.

Till the end of four months, I believe, the child makes no motions that are not automatic, reflexive, or instinctive. From the fifth month, perhaps, certainly in the sixth and seventh months, imitative motions appear, the nature of which is obscure, but which are of signal importance in the point of view of psychogenesis and education. It is hardly necessary to say that I am speaking of unconscious motions instinctively imitated, not of conscious and voluntary imitation, which will come much later.

Preyer seems to me to be under a mistake when he supposes imitation to be essentially voluntary. To my mind there is no will without an expressed intention. Where is the intention, the reflecting consciousness, when an infant, hearing another one crying, begins to cry by contagion, or when a child of seven months, seeing me tapping the table or the window with my fingers, executes a poorly imitative scratching with his fingers? Nurses teach children at this age to say good-by with a motion of the hand, which their wards imitate at sight. I was recently told of a boy twelve months old on a railway train, who, when his father, to quiet him, snapped his fingers in his face, immediately imitated the motion, to the surprise of all. Rubbing my hands one day at the table, partly because of the cold, partly in idleness, I saw a little girl three years old stop eating to rub her hands too. The same child, when twenty months old, seeing an image of a crying child, by an unconscious imitation opened her own mouth. Children laugh when they see people laughing, yawn, sing, cough, spit, snuff the candle, light a paper at the fire, and pretend to read and write, long before they comprehend any of those acts. One of their greatest pleasures is to imitate the cries of animals, either spontaneously or after another. Their plays are nearly all imitations of adult life. When they hear a story that engages them, we can see them taking on, one after another, the expressions of the characters; and when they begin to speak, they repeat all they hear, including oaths and other bad words, which it horrifies us to hear from them. It is hardly correct to see in this aptitude of children to imitate a sign of inferiority, as Delaunay did. It is rather a promise of intelligence. What is called the child's docility results largely from these endowments. It learns everything, at first, by imitation—to speak, write, and sing. Unconscious imitation accounts for many facts—for the fact, among others, that in a family of several children the younger ones are often more advanced than their elders were at the same age. But this more than half animal plasticity is not really intelligence, although it announces it; and it is truly unfortunate if age comes upon one without giving him something better than this simian and parrot-like disposition.

These imitative motions, at first wholly involuntary, are the ones which the will will take hold of to make them its own or to suppress them. Habit, however, renders them indelible. Hence it is never too soon to watch against them. As Preyer well says, everything that could lead its imitative tendency into dangerous ways should be removed from the child. The first duty of education is to look after the surroundings of children, who can not grow up healthy except in a wholesome medium. To comprehend the weakness of the will against imitation re-enforced by habit, we have only to recollect the struggle we have had against the tendency to do what we have been accustomed to do. Usually reason accommodates itself to the situation. Anticipated and led on, it does what is easiest. It seeks, and always finds when it seeks, reasons in favor of inveterate acts, and invents sophisms to justify them.

Voluntary motions are the intentional ones, or those which depend essentially upon conscious thoughts and feelings, representations and emotions. The will appears at a relatively late stage of the general development, when the senses have furnished a rich provision of images and the consciousness of a considerable number of feelings. Not till then can there be at the same time the conception of various possible motions, foresight of what should result, comparison, preference, and choice, or a relatively clear acquiescence in certain acts to the exclusion of others.

There is no sign of will so long as the child performs only unconscious, automatic, reflexive, instinctive, or imitative motions independently of its previously acquired ideas and pre-existing affections. Will begins when a thought properly so called becomes motive in itself, or in the desire accompanying it; when a movement known to be possible is anticipated with its results, and is accomplished intentionally. Not that every detail of the matter is understood, for even adults are not thus acquainted with the inner mechanism of their movements; but it should be represented in advance, preconceived as a whole, and determined originally by the thought of the new that it will introduce into the consciousness of the subject. Observers seem agreed that there can be nothing of this kind before the fourth month. Will appears when the child, for example, associates the thought of an object to be taken with that of making a motion to take it. It is, as it were, revealed to itself when after awkward and fruitless attempts the child meets a sudden success, discovers his power, and gains confidence in himself. From this time on the will gathers force with the number of such associations as they are more and more frequently repeated, and with the number of such efforts becoming more and more sure and successful.

The will presenting the double aspect of a choice between a number of possible acts and of ends to be sought, and of a conscious effort to use the means by which the object is to be reached, its growth is also double. It becomes more worthy of attention as the consciousness, growing richer in ideas and feelings, obtains a larger choice of ends and means, and as the active energy becomes capable of stronger and more consecutive effort.

As the faculty of voluntary motion is developed, movements which were at first fortuitous, unconscious, and ignorant of objects, executed without intentional direction or prevision, mechanically or upon chance impressions of the senses, are taken notice of, become gradually more closely associated with the perceptions, executed with increasing ease and accuracy, and more and more the effect of an express will or conscious energy, which knows what it is doing and does what it wants to. This energy, although it takes on a new name, does not invent a single new movement and creates nothing. The power of attention is an essential factor, perhaps the principal one, and makes of an energy in the beginning dispersed a concentrated and intentional energy. We can not determine to what point attention is at any age the condition of a rich mental and moral development. But when the child, having taken notice of its incoherent and awkward movements, begins the effort to co-ordinate them in view of precise ends; when, for example, it moves symmetrically both arms to embrace or both hands to take; when, inversely, it isolates movements formerly associated, stepping on one foot to push the ball with the other, striking with one hand the dish which it is holding in the other—it is already performing an act of the will.

There is a kind of struggle for existence among the thousand vague movements of the eyes, arms, hands, feet, and head. Those which are useless or injurious are eliminated. Those which are advantageous, that procure a physical or moral satisfaction, are repeated, predominate, and are accomplished in better style. From involuntary they become voluntary, while many, again, escape the will to become habitual. Preyer gives a minute description of the various motions of the child and their progress, which we can retrace daily in its general features, in the attitudes and motions of the head, for a long time directed very awkwardly, even in taking the breast; the motions of prehension, apparently more natural and often easier to the child than the act of letting go, when it has a hold; the gradual way in which it learns to sit down and remain seated, to creep, to get along on its knees, to rise upon its feet, to stand, to let go of the support, and to walk.

It is a law of some of the motions we are talking of that exercise perfects them; we can, therefore, to a certain degree, hasten their development. But we must be very careful how we do this, for every premature exercise is accompanied by dangers; all precocity is paid for in bad money. The precept, *follow Nature,* is especially pertinent in the earlier years. Then, more than ever, Nature takes her revenge if we try to hurry her and do violence to her. No artificial excitations. They are rarely necessary, and are dangerous.

People sometimes ask, At what age can we seat a child in a chair; when put him on his legs; how old must he be before we teach him to walk? The answers are easy. He must not be made to sit till he has spontaneously sat up in his bed and has been able to hold his seat. This sometimes happens in the sixth or seventh month, sometimes later. The sitting position is not without danger, even when he takes it himself; imposed prematurely upon him, it tires the backbone and may interfere with the growth, so the child should never be taught to stand or to walk. That is his affair, not ours. Place him on a carpet in a healthy room or in the open air, and let him play in freedom, roll, try to go ahead on his hands and feet, or go backward, which he will do more successfully at first, it all gradually strengthens and hardens him. Some day he will manage to get upon his knees, another day to go forward upon them, and then to raise himself up against the chairs. He thus learns to do all he can, as fast as he can, and no more.

But, they say, he will be longer in learning to walk if he is left to go on his knees or his hands and feet indefinitely. What difference does it make if, exploring the world in this way, he becomes acquainted with things, learns to estimate distances, strengthens his legs and back, prepares himself, in short, to walk better when he gets to walking? The important thing is, not whether he walks now or then; but that he learn to guide himself, to help himself, and to have confidence in himself. I hold, without exaggeration, that education of the character is going on at the same time with training in locomotion, and that the way one learns to walk is not without moral importance. From different points of view, but for reasons identical at the bottom, hygienists and moralists agree in disapproving of leading-strings. In a moral and physical sense, the pre-eminent educating agent is liberty, natural activity, unfolding itself without constraint under a discreet surveillance that is limited to removing grave changes and preventing real faults. The necessity of such surveillance is otherwise evident from the fact that the body of the child, on account of its extreme suppleness, takes every sort of wrinkle, if we may speak thus, with equal facility. Vigilance at every moment is all that can prevent it from contracting every kind of vicious habit; the great point is to reconcile such vigilance with the liberty which its spontaneous development demands.

The progress of voluntary motions reaches its goal when they are willed, so to speak, in all their parts, going to their clearly conceived end by the simplest ways, with the greatest precision and accuracy. Then there is no more fortuitous or indeterminate motion, no more expenditure of useless force. Such a triumph of reflective activity may be observed, for example, in the accurate designer. Those know how much time and pains it takes to reach that point who, trying to teach children to write, have seen them at seven or eight, or more, years old, twist themselves, make faces, stick out their tongue, pucker their lips, and make ten useless movements to one useful one. This brings us back to the important fact that inhibition of noxious or useless acts, of automatic motions having no necessary relation to the willed act, is an essential element of the progress of mobility.

This is equally the case in the progress of the will generally. In morals, too, when the act consists as much in the inner resolution as in the motion that carries it out, while the will may begin by being a hardly conscious effort of desire tending toward its object, it will end by being to a large extent the contrary—or a conscious and intentional restraint, a spontaneous inhibition. I say spontaneous; but a long time will pass before the child becomes capable of controlling himself, of spontaneously resisting his impulses and desires; he will have to be helped in it at first.

It is the office of education to put the first check upon some of these impulses to the advantage of others, to oppose thought to thought, tendency to tendency, and fear to desire. That is why the subjection of children to a firm discipline is always the beginning of education. To resist them is to hold them up. To bend them to a rule, as broad as you please, but inflexible as to what it prohibits, to prevent their doing what ought not to be done, to exact from them only what is necessary, but exact it firmly, is to prepare them to govern themselves.

But, so far as the inhibition is not the child's own act, it is not an act of the will. It does not become that till after having been imposed often from without, and, having thereby become less painful, it is appreciated by the child itself for its results, and the will becomes the possessor of it. This is the reason that while the earliest discipline should be firm, it must nevertheless be broad and liberal, and become more and more so as the reasoning faculty is developed. I call broad and at the same time firm a discipline which, without yielding anything to caprice, or to the unregulated and tyrannical demands of the child, purposely avoids loading him down with prescriptions and prohibitions, and leaves him as much elbow-room as possible in order to accustom him to frank action and the free exercise of his faculties under his own responsibility. It must not be forgotten that, while the inhibition imposed upon him is a means, voluntary inhibition is the end. The purpose is to initiate him into self-restraint and self-government, and he can be prepared for it only by being exercised in it.

Preyer is not quite clear in marking the distinction between not wishing and wishing not. We define two distinct species of inhibition; one voluntary, and the other really willful. The first takes place when a child under restraint and watch abstains against his own inclination from doing what is prohibited—for example, when he stops crying when interrupted by a stranger, or when in the garden he draws back from a trespass he is about to make upon the turf at the sight of the watchman. There is in those acts what may be called a simple non-wishing, for the thing that counteracts the temptation is something outside of the child's will. But when the child, free and alone, finds spontaneously in his own thoughts and feelings a counterpoise to his temptations, there occurs an inhibition of a new kind, which is not simply a non-will but a positive and meritorious will. Moral education consists essentially in gradually substituting this kind of inhibition for the other, the empire of reason for that of constraint.

It does not really begin so long as we only guard, watch, and prevent. Innocence thus obtained has only a provisional and preparatory value with the child, and none with adults. Some young people have been brought up in this way, under conditions of complete surveillance, kept in leading-strings till they were twenty years old. This is better than nothing, in so far as the object is to prevent their making fools of themselves; but their parents are mistaken if they believe they have been well trained; they have not been trained at all. They are like the cat that withholds its paw from the tempting dish as long as it sees the stick, but which is secretly eager to get its chin in.

That person alone is morally trained who can watch and conduct himself; who, as Montaigne says, "has enough in his own eyes to keep him in office." Education ought gradually to lead children to this point, prudently risking a little, loading them from the beginning with as few restraints as possible and loosening these little by little, making only reasonable demands and explaining the reasons for them as fast as they can be comprehended. I do not hesitate to measure the value of an education according to the degree in which it has sought to teach the child from the cradle to help himself and govern himself—to make men who shall be characters.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

WHAT KEEPS THE BICYCLER UPRIGHT?*

By CHARLES B. WARRING, Ph. D.

THERE is something weird, almost uncanny, in the noiseless rush of the 'cyclist, as he comes into view, passes by, and disappears. Pedestrians and carriages are left behind. He yields only to the locomotive and to birds. The apparent ease and security of his movement excite our wonder. We have seen rope-walkers, and most of us have tried to walk on the top rail of a fence, and have a vivid recollection of the incessant tossing of arms and legs to keep our balance, and the assistance we got from a long stick or a stone held in our hands. But the 'cyclist gets no help. His legs move only in the tread of the wheel, and his hands rest quietly on the ends of the cross-bar of his machine. The rope-walker keeps every muscle tense, and every limb in motion or ready to move. No wonder, when a tourist on his bicycle spins for the first time through a village here, or among the nomads of Asia, he is followed by a gaping crowd, till his machine carries him out of their sight.

We involuntarily ask, How is it possible for one supported on so narrow a base to keep his seat so securely and, seemingly, so without effort?

For an answer to this question I have searched somewhat widely, and, while I have found articles enough on or about the bicycle, and what has been done by its riders, I have found none that offered a reasonable theory for its explanation. This is my apology for presenting the present paper. In it I shall state the theories which have been offered, the reasons why they are unsatisfactory, and then give what appears to me the true *rationale* of the machine.

The only paper I found that claimed to explain the bicycle was one by Mr. C. Vernon Boys, entitled The Bicycle and its Theory. It was delivered before a meeting of mechanical engineers, and is reported at great length in Nature, vol. xxix, page 478. Here, thought I, is something valuable and convincing. But, on examination, I found that, out of several pages of closely printed matter, the Theory occupied possibly a dozen lines. All the rest was about the bicycle and what had been done on it, but not another word about its theory. We are told that Mr. Boys exhibited a top in action, and requested his audience to notice its remarkable stability. Then he said that the stability of the bicycle was due to the same principle, but made no attempt to show any connection between them. The top revolves on its axis, and

* A paper read before the Vassar Brothers' Institute.

it stays up as you see; the wheel of the bicycle revolves on its axis, and therefore it stays up, was his theory and demonstration, and the whole of it, and, so far as one can judge from the report, he was satisfied, however it may have been with his audience.

Of all machines, none seem to be so little understood as the top and its near relation, the gyroscope. Hence the best that can be said is, that the lecturer availed himself of the tendency found in most minds to "explain" an unfamiliar phenomenon by referring it to some other more familiar one, longer known, but equally incomprehensible—as if, as in grammar, two negatives make an affirmative, so, in physics, two unknowns make a known.

Without going into the theory of the top, or of the gyroscope, it is easy to show experimentally that their stability and that of the bicycle must be due to different principles. I spin on the table before you a top with a somewhat blunt point (Fig. 1). You notice it runs around in a circular or rather a spiral path, and gradually rises to a perpendicular. I strike it quite a hard blow, but do not upset it. I send it flying across the table, or off to the floor, but still it maintains its upright position. You notice that, when it is perpendicular, it stands still; but, if it leans ever so little, it immediately begins to swing or gyrate around a vertical axis. I now change the top for one whose point is very fine and well centered and sharp (Fig. 2). You see that it hardly

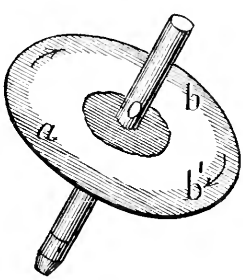


Fig. 1.—Blunt-pointed Top.

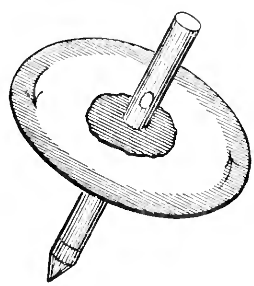
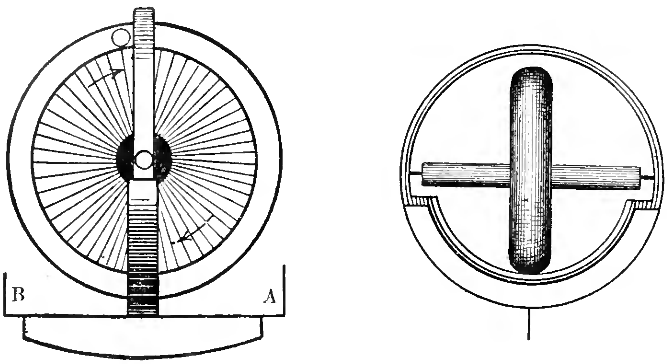


Fig. 2.—Sharp-pointed Top.

travels at all. I now cause the point to fall into a slight pit in the surface of the table: it ceases to travel, but continues for a very considerable time to swing around a vertical axis, and is remarkably stable, whatever the angle at which it leans. Stopping its traveling has, as you see, no effect upon its stability; but now I put my pencil before the axle and stop the gyration or swinging around. Immediately the power of staying up is gone, and the top falls. I may vary the experiment in every possible way: so long as the axis is inclined, the result is the same; the moment the gyration ceases, the top falls.

In the case of the bicycle there is no gyrating around a vertical axis. Whatever else it may do, it does not do that. Yet, as you saw, gyration is absolutely essential to the effect which Mr. Boys thinks accounts for its stability.

We may, I think, dismiss the top from further consideration; but there is another instrument apparently much closer in its relation to the bicycle. I mean the gyroscope, or rather that form of it which Sir William Thomson calls a gyrostat. Its wheel is upright like the bicycle's (see Figs. 3 and 4). The lower part of



Figs. 3 and 4.—The Gyrostat.

the ring which supports the wheel rests in a kind of trough, to the bottom of which is attached crosswise a piece of metal (best seen in Fig. 3) curved on the lower edge, and with two projecting wires by which it may be drawn back and forth in the plane of the wheel.

I now set the wheel in rapid motion—much more rapid than any bicycle-wheel can go; I place it on a smooth, hard surface—I have here a pane of glass—and leave it to itself. It begins at once, as you see, to revolve around a vertical axis. If it leans little, it revolves slowly; if it leans much, it revolves faster. It will not fall to the table, though I push it, or strike a hard blow. It resists with remarkable force. I now take it by the projecting wires and attempt to make it move in a straight course, as a bicycle does when it spins along the road. Instantly it falls. The rotation of the wheel on its axis was not in the slightest degree interfered with, but the stability vanishes the moment the rotation around the vertical axis ceases. Invariably it falls. Yet you observe the conditions are far more favorable for the effect of gyrostatic action than in the bicycle, for the mass of the rim of our gyrostat is many times heavier in proportion to its size, and its speed incomparably greater. I try the experiment over and over, the result is always the same. No amount of skillful management will make the instrument stay up for an instant if it has to move in a straight line. I submit that these experiments are proof positive that the sustaining power of the bicycle does not come from any gyroscopic action.

Others find in its going so fast the reason why the bicycle does not fall—referring, of course, in a blind way to that principle embodied by Newton in his first law: "A body in motion, if left to itself, will continue to move in a straight line forever." A brief examination will, I think, convince you that this, too, fails to account for the effect which we know is somehow produced.

It is another principle in physics that two forces acting at right angles to each other do not interfere. Each produces its own effect as fully as if the other did not act. For example, if a certain force sends a body (D, Fig. 5) north at the rate of ten feet in a second, and another force sends it east at the same rate, at the end of one second it will have gone ten feet north and ten feet east, exactly as if each force had acted alone. Going toward A B does not in the least hinder its going toward B C. Now, in case of a bicyclist, his forward motion, whether fast or slow, is at right angles to gravity, hence does not in any way resist it; and, therefore, as it is gravity that causes him to tilt over, the forward motion will not prevent his falling.

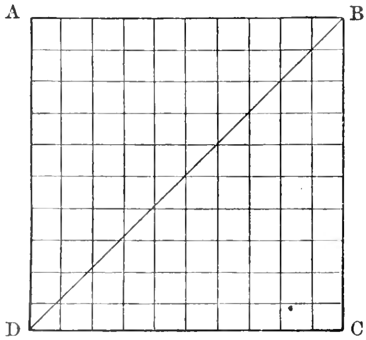


Fig. 5.—Diagram illustrating the Composition of Forces.

But it may be said that the force of gravity when the 'cycle leans, say to the right, is in fact resolved into two components, one vertical and the other lateral, and it is the latter only that causes the bicyclist to fall. This does not help the matter, for both components are perpendicular to the course of the bicycle, and hence its forward motion can in no way counteract either of them. Unless some other force comes into play, the bicyclist must fall toward whichever side he happens to begin to lean.

Many think they find this counteracting influence in "centrifugal force." You all are familiar with the effects of this "force." You feel them every time you turn a corner quickly, whether on foot or in a wagon, or on horseback. The bare-back riders in the circus lean well toward the center of the ring, to escape being thrown outward. We see its effect when the bicyclist spins around a corner. In such cases "centrifugal force" plays an important part, and is the real upholding force.

But centrifugal force is impossible so long as the body moves in the same direction—i. e., in a straight line. There must be change of direction, and, other things being equal, this force is greater in proportion to the abruptness of that change; or, as mathematicians say, the velocity being constant, it varies inversely as the radius of the curve in which the body moves. The larger the radius the smaller the centrifugal force. If the radius of curvature becomes infinite—i. e., the curve becomes a straight line—the centrifugal force becomes infinitely small, or zero.

So long, therefore, as the bicyclist does not turn corners—keeps in a straight course—the centrifugal force gives us no assistance whatever in understanding why he keeps his seat so securely. But yet it may be thought that this force, if supplemented by skillful balancing, is sufficient. It keeps the bicycle from falling when turning corners: will not good balancing account for the stability when moving in a straight course? We are all familiar with the phenomena of balancing one's self. We know the help a heavy pole gives at such times; how a person's legs and arms move with startling rapidity in the opposite direction to that in which he feels himself falling. There is nothing of this on the wheel. If the stability was due to balancing, it would not be so very difficult for a bicyclist to sit upon his machine when not in motion, and when its wheels both point in the same direction. I have never seen one that could do it. I suspect, however, that it is not impossible, any more than to stand on the top round of an unsupported ladder. But the ordinary bicyclist can not do it; and yet, without apparent effort, he rides securely. That his stability is not due to his balancing and to his rapid forward motion combined, is evident when we reflect that if the handles are made immovable, so that neither of the wheels can be turned to the right or left, it is impossible for any ordinary rider, no matter at what speed he may move, to keep from falling for any considerable time after he once begins to tilt.

Apparently the fact that some can ride "hands off" on a safety wheel contradicts this, for, however it may be on an "ordinary," on a "safety" the rider can not guide it by the pedals, and as he does not touch the handles of the steering-wheel or the wheel itself, it would seem that his not tilting must be due to good balancing. Experiment, however, proves the contrary. Let the steering-wheel be fixed by tying the handles, or by a clamp on the spindle, so that it can not turn to the right or the left, and then let the 'cyclist try to keep it erect. Balancing won't help, except possibly to delay his fall a few moments. And worse than that, he can't ride hands off at all if he tries to do so only by balancing. The explanation of such riding is not very difficult, but requires some other matters to be treated first. At present all I desire to establish is that in this kind of riding, as well as in all others, the rider's ability to keep from falling to one side for an indefinite time while traveling in a straight line is not due to balancing.

I think you will agree with me that the reasons thus far assigned for the stability of the bicycle cast little or no light upon the subject. Gyration has nothing to do with it; centrifugal force has no application to it, except when turning corners, or otherwise changing abruptly the direction of the movement; balancing is a detriment rather than an assistance;* and rapid motion alone accounts for nothing. Some other explanation is needed; this I shall now attempt to give.

Regarded mathematically as a machine for the application of force, the bicycle is a very simple affair. The weight (Figs. 6 and 7) is applied at the saddle, A, and is so great that the center of

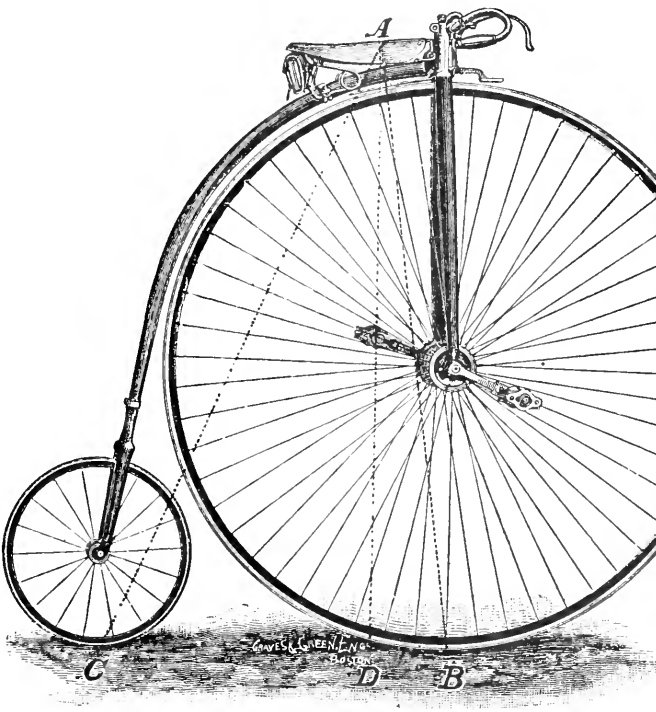


FIG. 6.—AN "ORDINARY" BICYCLE, WITH LINES OF FORCE.

gravity of the whole is very close to that point. A B and A C are the lines of force, B marking the point where the fore wheel rests on the ground, and C where the rear one. In discussing the forces that act on the machine we need consider only these lines, all the other parts being merely for convenience or ornament. It is evident that A can not of itself tilt either backward or forward, since a vertical line from it falls between B and C. In

* At the close of the reading of the paper, a teacher of the art of riding the bicycle, a man of large experience, arose, and, in the course of his remarks, said that one of the chief difficulties he had to contend with in teaching beginners to ride, was to induce them to give up all idea of balancing; that till this was done they could not ride well — a striking corroboration of the theoretical conclusion arrived at by the writer of this paper.

reference to them it is in stable equilibrium, while in regard to side motion its equilibrium is very unstable; the least thing will upset it.

To study the matter more conveniently, I have had a form made which eliminates all unnecessary parts and represents only

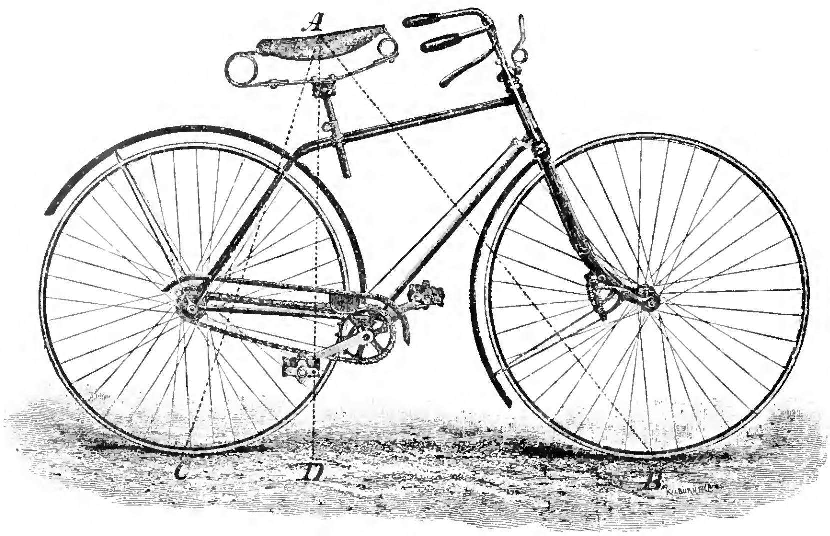


Fig. 7.—A "Safety" Bicycle, with Lines of Force.

the lines of force and the weight on the saddle (Fig. 8). It consists, as you see, of two long, slender pieces of pine, and looks like a huge capital A, the cross-piece serving merely to hold the whole more firmly together. At the apex, A, I have placed a few pounds of lead to represent the rider's weight.

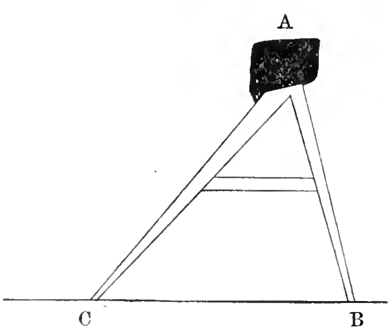


Fig. 8.—Apparatus illustrating the Way a Bicycle is kept Upright.

In the older form of the bicycle, the wheel in front is very much the larger. The corresponding leg, A B (Fig. 8), is much steeper and shorter than the other. In "safety 'cycles" it is just the reverse, the rear leg being steeper and shorter, while the two wheels are of nearly the same size. As the theory of both machines is the same, I shall, for the present, speak only of the former.

For convenience in handling, and that it may be better seen, I place the foot C, the rear one, on the table, and hold the other, B, in my hand, and at the same height from the floor. Now, notice: the weight at the apex, or saddle, begins to tilt to the right; I quickly move my hand to the right till it comes under the weight. If the saddle tilts to the left, I move my hand quickly to the left. In every case, by moving my hand more rapidly than the weight tilts, I bring the point of support under it. It is very easy in this way to keep the weight from falling; and that is the way the bicycle is kept upright.

But you will ask, How can the rider move the point of support when it is on the ground, and several feet out of his reach? He does it by turning the wheel to the right or left, as may be necessary—that is, by pulling the cross-bar to the right or left, and thus turning the forked spindle between whose arms the steering-wheel is held and guided.

But, some one will say, How does turning the wheel bring the point of support to the right or left—whichever the machine may happen to be leaning?

Let us suppose a 'cyclist mounted on his wheel and riding, say, toward the north. He finds himself beginning to tilt toward his right. He is now going not only north with the machine, but east also. He turns the wheel eastward. The point of support, B (Fig. 6), must of necessity travel in the plane of the wheel; hence it at once begins to go eastward, and, as it moves much faster than the rider tilts, it quickly gets under him, and the machine is again upright. To one standing at a distance, in front or rear, the bottom of the wheel will be seen to move to the right and left, just as I moved the foot of the skeleton frame a moment ago.

I conclude, then, that the stability of the bicycle is due to turning the wheel to the right or left, whichever way the leaning is, and thus keeping the point of support under the rider, just as a boy keeps upright on his finger a broomstick standing on its smallest end.

It may be questioned whether the bottom point of the wheel really travels faster than the weight at the saddle tilts over, and, if it does not, then the explanation which I have been giving fails.

By an easy calculation, based on the well-known principle that the velocity of a body moving under the influence of gravitation varies as the square root of the height from which it has fallen, irrespective of the character of the path it has described, I find that when the rider's seat is, e. g., sixty inches high, and the machine has inclined, say, six inches out of the perpendicular, it is at that instant, if free to fall, tilting over at the rate of much less than a mile an hour. But six inches is a large amount to lean—a good 'cyclist does not lean that much—we will suppose him out of plumb only three inches; then his lateral movement will be at the rate of only some twenty-two hundred feet in an hour. If the tilt is less, the falling rate will be less. To keep the center of gravity over the base, the bottom of the wheel needs only to move to the right or left—whichever the machine is leaning—somewhat faster than these slow rates. There is no great difficulty in doing this, for, if the bicycle is going eight miles an hour, it is necessary to change its course only about seven degrees; if four miles, then only about fourteen degrees; if two miles, then about twenty-eight degrees. The greater the speed, the less the angle: at sixteen miles an hour, the wheel would need to be turned less than two degrees. From which follows the fact, well known to 'cyclists, that the slower the machine is traveling the more the handles must be turned, and the more difficult to keep from falling.

From the fact that the bicycle is kept erect by keeping its point of support under it, like a pole standing upright on one's finger, some curious and, to most persons, quite surprising results follow. I have here three rods, respectively one foot, three feet, and seven feet long. I hold the last, as you see, very easily; the second not so easily; and the first only with considerable difficulty. I now put a cap of lead weighing four or five pounds on the top of each, and then again support them as before. In every case it is now easier to keep them from falling. Hence, in a bicycle, the higher and the heavier the load, the less the danger of falling; and, as most of the weight is in the saddle, the center of gravity of the whole is very near it, and it is the height of that, and not the size of the wheel, that affects the lateral stability. A rider with a load on his back, whether a bag of grain or a man sitting on his shoulders, is by all that the more safe from falling either to the right or left, however it may be as to headers.

Experts sometimes ride for a considerable distance with both legs over the cross-bar. But there is nothing strange in this, for placing their legs in that position only raises the center of gravity, and hence really adds to the stability. If in some way they can manage to turn the cross-bar, they can ride without difficulty until the momentum is exhausted.

A much more difficult feat is to ride on one wheel. The small wheel—the rider holding the other in the air—is most easily managed. It is merely a case of supporting on a small base a long, upright body. One keeps moving the point of support so as to bring it under the center of gravity. It needs only a quick eye and a steady hand. It is much more difficult when the 'cyclist uses only the big wheel, the other having been removed, for he is liable to fall forward or backward, as well as to either side. To avoid the first and second, he leans forward a little beyond his base, and would pitch headlong, but that he drives the wheel forward by means of the treadles just fast enough to prevent it. We all do the same thing when we walk. We lean so far forward that we would fall, did we not keep moving our feet fast enough to prevent it. On the single wheel most of us would fail, because from lack of experience we would make the wheel go too fast, and so would fall backward; or else, not fast enough to keep from falling on our faces. As to falling sidewise, that is prevented exactly as when both wheels are used—the rider turns the cross-bar to the right or left, and propels the machine in that direction. Experience, a level head, and a steady hand tell how far to turn it.

From mere inspection of Fig. 6 we see that safety against headers varies inversely as the height of the saddle, and directly as the distance from the foot of the perpendicular A D to the forward point of support B (Figs. 6 and 7). In other words, the higher the saddle, the greater the danger of headers; and the farther back, the less the danger.

As to the law of lateral safety—i. e., against falling sidewise—it is in one respect the reverse of the other, for the greater the height of the saddle, the easier not to fall to either side, just as it is easier to keep upright on the end of my finger a long stick than a short one.

PROFESSOR HUXLEY ON THE WAR-PATH.

By the DUKE OF ARGYLL.

I.

On the boundless subject of religion it is not possible for any man, within the limits of a magazine article, to set forth his whole mind. If those who write such papers have cause to feel this, those who read them have not less occasion to remember it. Misconception is a constant danger. Beliefs which seem to be vehemently repudiated may nevertheless retain some hold when differently expressed. Doctrines which seem to be insisted on with passion may yet not be held without important modifications. These reserves may not be expressed only because the occasion for expressing them did not seem to arise. Large portions of the whole subject may be left out of view. Those which are actually dealt with may be treated, from the accidents of controversy, in a narrow and angry spirit.

It is with a sincere desire to remember all these reasons for caution that I now call attention to the article by Prof. Huxley published in this Review for the month of July, 1890.* But, in full remembrance of the caution, we may fairly say that this article is an open and avowed attack upon Christianity. Nobody has any right to complain of this. But everybody has a right to

* Ninteenth Century, July, 1890, The Lights of the Church and the Light of Science.

identify and recognize it as a fact. That article is not a mere attack upon certain narratives and traditions of the Old Testament, on the ground that they have been incautiously admitted as integral parts of Christian belief, while in reality they need not and ought not to occupy any such position. On the contrary, this contention is repudiated expressly, and with scorn. Prof. Huxley patronizes the school which insists on the barest literalism in the interpretation of the Hebrew Scriptures. He refers to Canon Rawlinson's Bampton Lectures (1859) as asserting that "the narratives contained in the canonical Scriptures are free from any admixture of error."* He praises the justice and candor of the lecturer when he asserts as distinctive of Christianity among the religions of the world, that it claims "to be historical." † He represents him as insisting that Christianity is surely founded "upon events which have happened exactly as they are declared to have happened in its sacred books." ‡ He further ascribes to the lecturer the argument that the "New Testament presupposes the historical exactness of the Old," and that the demonstration of the "falsity" of the Hebrew records, especially in regard to those narratives which are assumed to be true in the New Testament, would be fatal to "Christian theology."# Having thus nailed the colors of Christianity to the bare poles of the very barest and narrowest literalism, the professor jumps and leaps upon this teaching as giving him an easy fulcrum for tearing those colors down. He is enchanted by the reasoning of the Canon. He adopts it with effusion. "My utmost ingenuity," he says, "does not enable me to discover a flaw in the argument thus briefly summarized." ‖ Nor does he conceal the full sweep of the destructive work which he desires it to accomplish. Not only the whole story of Creation, the whole story of the Fall, the whole story of the Flood, the whole story of Abraham and of any special mission to the Hebrew people, but even the glorious idea and hope of a Messiah—the whole Messianic doctrine which binds the Jewish and Christian Churches—all are relegated to the same category as the Greek myths about Theseus or the Latin stories of the regal period of Rome. And, as the writers of the New Testament have believed those stories and dwelt upon them, the authority of those writers is denounced as that of a body of men who "have not only accepted flimsy fictions for solid truths, but have built the very foundations of Christian dogma upon legendary quicksands." ^

This language—with plenty more of it—is unmistakable. Its tone is that of the whole article. It must be accepted, therefore, as a pronounced attack upon Christianity all along the line.

I do not stop to inquire whether the doctrines of biblical inter-

* Page 7. † Ibid. ‡ Ibid. # Ibid. ‖ Page 8. ^ Ibid.

pretation which he ascribes to two eminent divines of the Church of England are or are not fair and correct summaries of their teaching. Fortunately, on this subject we are not at the mercy of any individual divines whether living or dead. The Christian Church, with its long and varied history of nearly two thousand years, has never been committed to it. The doctrine indeed of verbal inspiration, though never defined and never authoritatively adopted by any Christian Church, has been often widely prevalent. But even this doctrine is exaggerated, distorted, and made ridiculous by its development in the hands of Prof. Huxley. As patronized by him, the law of interpretation applied to some of the most ancient records of our race would exclude all the elements of allegory and of metaphor, of imagery, of parable, and of accommodated presentation. And this, too, when some of these records purport to set before us an idea of the origin of things. The argument is not only illogical but grotesque, that because Christianity claims to be an historical religion, therefore it follows that any accepted narrative attempting to give us some conception of the creative work, must do so in words as literal and prosaic as an account of the execution of Charles I.* Creation, strictly speaking, is inconceivable to us. And yet creation is a fact. The system of visible things in which we live was certainly not the author of itself. If we are capable at all of receiving any mental impression of its beginnings we can only do so through modes of representation which are charged with allegory. In his own special science no man has declared more clearly than Prof. Huxley that the limits of our observation are not the limits of our knowledge. Biology, for example, declares as its verdict, after much evidence has been taken, that, as matters now stand, the living is never generated by the not-living. Every form of organic life comes from some other older form which has already been established. But he points out that this has no adverse bearing upon the deductive conclusion that life must have had its first beginning otherwise. On the contrary, he admits that conclusion to be certain. "If," says he, "the hypothesis of evolution is true, living matter must have arisen from not-living matter."† I venture to add that whether the theory of evolution be true or false, or whether (as is more likely) it be partly true and partly false, the certainty of this conclusion is not affected. But if that beginning is to be rendered conceivable by us, it can not be expressed in the language of experience. We have no experience to go upon. Of necessity, therefore, the very idea of a beginning must be dealt with in the language of metaphor or allegory. Accordingly, even Darwin was compelled to have recourse to the

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* Page 7. † Encyclopædia Britannica, ninth edition, vol. iii, Biology, p. 689.

familiar imagery of the Hebrew Scriptures when he had to express his idea of the origin of life. There were certain germs, he assumes, into which "life was first breathed." What should we think of the rationality of a man who interpreted Darwin to believe that there was some big Being who originated life by emptying his lungs into certain bits of protoplasmic jelly? Yet this is the law of interpretation which Prof. Huxley would impose upon the magnificent symbolism of Genesis. The events described—avowedly transcending the region of experience—must have happened "exactly as they are declared to have happened in the sacred books." When we are told that God said, "Let there be light," we are to interpret this sublime image as an assertion that the Almighty did actually address this sentence in a definite language to the brute elements of chaos. We are to understand that the words thus attributed to the Creator were actual words, like the words spoken by King Charles to Bishop Juxon on the scaffold at Whitehall. If we don't believe this, we are to believe nothing whatever coming from writers so unhistorical. In like manner, when we are told of the Almighty walking in an earthly garden "in the cool of the day,"* and when the narrative seems to imply that Adam saw him and hid, we are to understand this baldly and literally as an actual midday scene in a shady wood somewhere in western Asia. Such is the childish argument which is to destroy Christian theology—such is the kind of logic in which Prof. Huxley can not, for the life of him, see any flaw. St. John may perhaps be credited with knowing, at least as well as the professor, what would and what would not be fatal to Christian theology. Yet he does not seem to have been even conscious of the difficulty. Passages even stronger and more definite in the Old Testament, involving hyperbole, metaphor, and imagery, stood nothing in his way. He must have known the famous passage in Exodus † in which Moses is represented as having spoken with God as a man speaketh with his friend. Yet the professor's canon of interpretation is unknown to him. "No man hath seen God at any time" is the grand sentence of the apostle. ‡ But the extension of this argument to destroy all authority as belonging to the writers in the New Testament is perhaps a still more remarkable illustration of the reasoning which the professor considers to be faultless. Men who accepted such narratives as those of Genesis are not to be trusted as themselves historically safe. If St. Paul did really believe in those primeval narratives we can not trust him when he tells us of the light which burst upon him on his way to Damascus, and which changed him from a persecutor of the faith into the great

* Genesis, iii, 8. † Exodus, xxxiii, 11. ‡ John, i, 18.

apostle of the Christian Church. And so of ourselves. If we do not consider ourselves bound to hold that an actual serpent was selected as the most persuasive advocate of evil—if we are disposed to think that there is all the air, and all the most obvious characteristics, of allegory in such words as the "tree of the knowledge of good and evil"—if we do not accept it as a literal fact that the rotation of the earth was suspended to keep the valley of Ajalon above the horizon for a longer time than was due to the season of the year, then we are equally bound to distrust the truth of the migration of Abraham, and of the sojourn in Egypt, and of the conquest of Palestine, and of the Babylonish captivity, and of the stream of prophecy pointing to some great Deliverer not for the Jews only but for all peoples—and of the life and death and teaching of our Lord. The whole argument, I confess, appears to me to be not only illogical, but irrational.

This is a subject, however, of vast extent on which we have no right or reason to expect any special light or guidance from Prof. Huxley. Even if he approached it in the careful and cautious spirit in which he has generally dealt with his own noble science of biology, it would not follow that he could deal with it as well. We know the confession which Darwin has made of the effect upon his own powerful mind of exclusive devotion to one class of ideas and to one purely physical pursuit, in rendering him comparatively insensible to the whole class of conceptions which are the warp and woof of the higher branches of philosophy. Even in this article, Prof. Huxley tells us that when he tries to follow those who walk delicately among "types" he soon "loses his way." * This is a strange confession to make when even in his own special science "type" is one of the most familiar of all words, and when the suggestions connected with it—for example, on the general development of the vertebrate skeleton—are confessedly of the most profound and far-reaching interest. It is still more strange when he himself—walking so delicately as to be most difficult to follow—has tried his hand at the definition of a "type." It is, he says, a "plan of modification of animal form." † He tells us he has "a passion for clearness." Is the above definition perfectly pellucid? All animal form is in itself a "plan." Each modification, we now hear, is another "plan." Is this what he means? And if so, what does he mean by a "plan"? Does he mean what all other men mean by the word—some mental conception with a view to the future? Or does he mean only some accidental pattern such as a drop of water may leave when it splashes on a window-pane? Then, what does he mean by a "modification"? Does he mean some wonderful adaptation to

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* Page 20. † Comparative Anatomy, p. 7.

some special use? And if he does, how does he account for that adaptation arising exactly when and where it is needed? Was it purely accidental? Does he worship at the shrine of the great goddess Fortuity? Where is his "passion for clearness" when all these questions are evaded? If he finds such mysteries in a purely physical science, why should he sneer at conceptions also "seen through a glass darkly," in the spiritual regions of belief? He is certainly narrower than the higher aspects even of his own pursuit. But, besides the cramping effect of all specialisms when exclusive, Prof. Huxley has most clearly approached the subject under the strongest animus. "The slings and arrows of outrageous" clerics at church congresses seem to goad him on. His one desire appears to be to trample on them. If he can here and there catch some popular divine committing himself to some argument or idea which may be ridden to the death, he hugs it with effusion. He gives it the requisite dressings of his own verbal evolution. Then turning round he endeavors to tie down the whole of Christian theology to ridiculous conclusions under the choppings of a childish logic.

But there is one thing we had a right to expect from Prof. Huxley, and that is, that when in the course of his argument he comes across questions of purely physical science, he should treat them as candidly and fairly when they are supposed to bear upon "Christian theology" as when he delivers a scientific lecture or writes an article for an encyclopædia. Yet this is just what he has failed to do in the case before us. His canons of biblical interpretation are not more crude and violent than his dealings with the discoveries of geology, and still worse, if possible, his dealings with the things which geology has not yet discovered. I proceed to define and illustrate what I mean.

Prof. Huxley selects the story of the Deluge as his particular battle-horse in the fight. He is quite right, and well within his right, in doing so. That story is special in the fact that it purports to give an account of an event within the limits of human experience, and that in doing so it narrates occurrences which may to some extent be brought within the cognizance of discovery in more than one branch of physical science. Prof. Huxley has a very definite theory as to the origin of the story. He thinks it probably arose out of some terrible inundation of the two great rivers of Mesopotamia.* This is quite an intelligible hypothesis, since we know from the facts of our own day, in the case of the Yellow River in China, what an enormous destruction of human life may be caused by river floods bursting in upon low, flat plains thickly peopled. But this hypothesis fails to give any adequate

* Pages 14, 15.

explanation of the universality—or nearly so—of the tradition of a great flood among all branches of the human race. The late eminent French scholar Lenormant marshaled and collated the evidence on this subject not long ago, and came to the conclusion that a tradition so wide-spread, if not actually universal, must have arisen from the memory of some great catastrophe which did actually take place, and had left an indelible impression on the progenitors of every race. Prof. Huxley takes no notice whatever of this argument, although the fact on which it rests is fairly stated in a careful and temperate article by Dr. A. Geikie, upon the Deluge, to which the professor himself refers.* No hypothesis which does not take notice of this fact can rest on adequate scientific reasoning.

The question then naturally arises whether it is or is not possible that there may have been, since the birth of man, some great catastrophe far more wide-spread than the inundations of any river; and whether the narrative in Genesis of the Flood may not be the account of this catastrophe—told in its religious aspect, just as the previous narrative of Creation is an account of that (to us) inconceivable operation—told in the same connection—that is to say, in its connection with the final causes of the Divine government and action.

Now, in dealing with this question scientifically there are three things which must be done: first, there must be a careful view given of the purely physical phenomena which are really of necessity involved in the form of the narrative in Genesis as it has come down to us; secondly, there must be another view given, as careful and complete, of any conclusions relative to the subject which have been really established by geology or by any other branch of the physical sciences; and, thirdly, there must be a frank and free confession of the ignorances of science—of the problems which it sees but which hitherto it has failed to solve, and of the unexhausted possibilities of physical causation which lie wholly unknown behind them. Prof. Huxley's article does not comply with any one of these conditions. He does not state fairly, but on the contrary most unfairly, what the narrative in Genesis does of necessity involve. He does not set forth fairly what are the related facts which geology may claim to have established; while—above all—with regard to the ignorances of science, he seems wholly unconscious even of that sober estimate of his favorite agnosticism which true science impresses on us all.

He starts with songs of triumph over the very general abandonment of the idea that the Deluge could have been universal, complete, and simultaneous over the whole globe. He might as

* Kitto's Encycl. of Bibl. Lit. Deluge.

well be jubilant over the cognate fact that the six creative days in Genesis are now never thought or spoken of as compelling us to believe that the whole creative work which has been done on our planet since it was in a state of chaos, was a work accomplished within six literal days of twenty-four hours each. Or he might as well shout over the still older movement of thought which divorced the conceptions of the Christian world from the literal language of the geocentric astronomy. It is quite a mercy that Prof. Huxley has not trotted out our old friend Galileo again, and has taken refuge in such later and lesser lights as the late Canon William Harcourt, and the still living Canon Rawlinson. But even on this question of the possible universality of a deluge, Prof. Huxley takes no notice of certain features in the Hebrew narrative which manifest a most curious avoidance of the real scientific objection to a complete and universal deluge, in spite of some language which appears to assert it. It is not true, so far as I know, that any science has proved a universal deluge to be a physical impossibility. In particular, it is not true that there is any deficiency in our existing oceans of a quantity of water adequate—more than adequate—to cover the whole earth. On the contrary, it is a fact that the actual distribution of sea and of dry land on our planet is such that even a comparatively slight elevation of the floor of our oceans, together with some corresponding depression of the land, would spill over upon our continents enough water to submerge them completely, and to submerge them all. My distinguished friend Dr. John Murray (of the Challenger Expedition) has calculated that there is enough water in our existing seas to cover the whole globe with water more than two miles deep. This is the latest calculation of scientific inquiry, and it is curious. The fundamental objection to a complete and simultaneous deluge at so late a period of the earth's history is not physical but biological. It lies in its bearing upon the history and development of organic life. Even this objection applies only to the completeness, and not to the universality, of a deluge. That is to say, biological facts may be perfectly compatible with the partial and contemporaneous submergence of every continent on the globe, but not with any such submergence having ever been total or complete. As regards the lower animals, there must have been, so far as we can reason, other refuges than an ark. There must have been many areas left uncovered. But this necessity is demanded quite as much by the narrative in Genesis as by the scientific evidence of the distribution of life. The repeopling of the deluged earth by ordinary generation requires this absolutely. The universal destruction of all terrestrial life would have necessitated a complete re-creation of all its forms. And yet this is exactly the consequence which the narrative in

Genesis definitely excludes. The writer ascribes the subsequent repeopling of the earth, both as regards the lower animals and men, not to any re-creative work, but to ordinary generation. The divine employment of natural means is the dominant idea of the whole narrative. But seeing that the dimensions of the ark represent a vessel considerably smaller than the Great Eastern, it is clear that without what are called miracles on the most stupendous scale—which the writer does not seem at all to contemplate—the whole creatures of all the continents of the globe could not have been represented in it, even if they could have been brought together and congregated in one spot in western Asia. The writer or writers of the narrative in Genesis, or those still older recipients of tradition in whose hands that narrative grew into its present form and through whom it was transmitted, had presumably no more knowledge of the very existence of the New World, or indeed of the extent of the Old World, and of the quantity of animal life which swarms upon both, than they had of the nature of the sun or of the orbit of the earth. What they conceived or thought upon this subject has no moral or religious significance. Whether the American mastodon and megatherium, and the European mammoth and the woolly rhinoceros, and all the other huge Pleistocene mammalia, were saved at all, even in single couples—whether all the lesser mammalia which have survived could or could not be saved from drowning by the refuge afforded in a single vessel—these are questions which do not seem to have been even thought of. Accordingly, the writer of the Epistle to the Hebrews does not even take the smallest notice of such questions, or, at all events, brushing them aside, fixes on the central conception of the whole narrative, the effect of the Deluge upon man, and the personal relations between one faithful patriarch and the Almighty Disposer of all events. He tells us that this one man "by faith, being warned of God of things not seen as yet, moved with fear, prepared an ark to the saving of his house."* Here we have the whole essence and purport of the narrative in the Old Testament condensed, and reproduced by a Christian disciple who, whatever his name, is certainly, humanly speaking, one of the most powerful among the writers of the New. It matters nothing to this view of it, whether the Deluge was or was not conceived to be literally universal, complete, and simultaneous. It matters nothing what may or may not have happened at the same time to the kangaroos of Australia, to the moas of New Zealand, to the giraffes and countless antelopes of central Africa, or to the llama and tapir world of the South American continent. If there is any

* Hebrews, xi, 7.

good scientific reasoning, as I think there is, which seems to prove that no deluge can have been at once complete, universal, and simultaneous, over the whole globe, then there is no more reason to believe it than there is to believe in the literal interpretation of the passages involving the rotation of the sun round the earth, or the still more striking passages which we have seen so summarily dealt with by St. John.

Leaving, therefore, Prof. Huxley to his jubilations over the general abandonment of a deluge at once complete, universal, and simultaneous, let us see how he proceeds to deal with the alternative of a deluge which may have been enormously wider than the Mesopotamian Valley, and yet may have been partial only—as regards the whole area of the globe.

The device of the professor is to assume that belief in any such deluge must of necessity involve the notion that while the existing levels of the land were fixed or unmoved, the waters were heaped up over some portion of it, without any containing banks or walls to keep or hold them in their new position. Over this ridiculous idea he runs riot and enjoys quite a happy time of it. He shows triumphantly how it contradicts the fundamental laws of hydrostatics, how impossible it is to conceive any agency by which such a heaping up of loose waters could have been effected, and how tremendous must have been the outrush when any (inconceivable) restraints were removed. Now I am not concerned to inquire whether this conception as to the cause of a partial deluge has or has not been ever formulated or distinctly pictured by any human being. Considering the absolute and wide-spread ignorance of all the physical sciences which prevailed in the world for centuries, it is quite possible that something like this may have been one of the popular ideas concerning the Deluge. It is perfectly natural that it should have been so. That in this world of ours the solid earth is the stable, while water is pre-eminently the unstable element, is the universal prepossession of mankind. It is not overcome even in countries where the land is often trembling under earthquakes or subject to the ravages of volcanic action. Over by far the largest part of the habitable globe, where men have not even these suggestive experiences to consider, the preconception is insuperable that the land is comparatively steady and that the sea is the most liable to change. That this preconception should have governed the reasonings of pre-scientific ages and of ignorant men of the present day is not astonishing; but it is most astonishing indeed to see it patronized by Prof. Huxley. The very first lesson of all geological science is to teach us and to make us familiar with the idea that in all relative changes between the areas of sea and land the element of constancy is in the liquid water and the element of mutability is in the solid earth. The sea is bound by the most rigorous laws to keep its general level. The dry land is under no similar bondage to keep either its general or its local elevation. On the contrary, the same great force which keeps water with its peculiar properties in a fixed relation to its supports is the very force which ceaselessly tends to make those supports yielding and unsteady. It is true, indeed, that the ocean leans against the land with an attracted bulge. This bulge is not visible to the eye, nor can it, perhaps, be measured by any mechanical instrument; but the mind of man has recognized it as a necessary consequence of the law of gravitation. All land-masses above the water must attract more or less the sea which is beneath them. Independently of this, from ordinary hydrostatic causes, the ocean must always be lipping over along its shores—ever ready, as it were, to take instant advantage of the smallest movement of depression. Deluges, therefore, by submergence are ever on the cards. They are the easiest and most natural operations in the world. Of course, Prof. Huxley knows all this, and, of course, he does not commit himself to any other doctrine; but he does argue against a partial deluge as if it involved of necessity the vulgar error of the sea being raised up and heaped over any area which may have been submerged. This is not ingenuous. What is the value of a scientific argument against any supposed occurrence which rests entirely on a popular delusion as to the physical causes by which that occurrence may have been brought about, while the controversialist knows all the time that the very same occurrence might very easily have been brought about by other causes perfectly natural and perfectly easy to conceive? Yet this is the way in which Prof. Huxley prances on his selected battle-horse of the Deluge. He elaborates picture after picture of the physical consequences involved in a partial deluge effected by a heaping up of unsupported waters over a fixed and steady land, and then he stamps upon the nonsense which he has himself adopted—in so far at least as it is useful to him, and has intensified where it could be made to be so.

This perverse dwelling upon an absurd physical conception, as a means of raising prejudice, is all the more gratuitous and irrelevant since, wherever else it came from, it certainly did not come from any description contained in the Hebrew narrative. On the contrary, one of the most salient and even mysterious characteristics of that narrative is that it is absolutely inconsistent with the idea of sudden, violent, and torrential action. Prof. Huxley himself, in the midst of his strained denunciation of what must have been involved in any partial deluge, stumbles on the fact that the Hebrew narrative assumes a rate of movement so slow and gradual that "if it took place in the sea, would be overlooked by ordinary people on the shore."* I say he stumbles upon it, because he mentions it only in so far as it comes handy for the purpose of showing the inconsistencies of the popular notions of heaped-up waters upon a steady land. But he does not deal with it or consider it in its true connection—namely, as showing that this popular notion finds no support in the Hebrew narrative. Dr. Geikie's early paper on the Deluge, written not lately but some thirty years ago, stands, as regards this, in creditable contrast with the heedless representations of Prof. Huxley. Dr. Geikie did, indeed, fall apparently into the same strange error of holding that every partial deluge must of necessity have involved a universal one, an argument which rests wholly on the notion that any such deluge must have been caused by a heaping up of water over a stationary land. But Dr. Geikie, with characteristic sagacity, emphasizes and dwells upon the fact that the Hebrew narrative does not suppose any violent or convulsive action, and that in this respect the popular imagination of it has been quite unjustified.† But even Dr. Geikie's paper, fair and candid as it intended to be, does not point out the unquestionable conclusions, that the whole idea of the narrative in Genesis assumes a deluge caused by a slow and gradual subsidence of the land, and not caused by any capture of it by some sudden assault and battery of the sea. This conclusion does not depend on the true meaning of archaic and obscure expression, such as the "breaking up of the fountains of the great deep," which are almost incapable of an exact physical interpretation. It depends on the structure of the whole narrative, and on the incidents which it includes. Its importance does not lie in any question touching the sources of that narrative, or the conceptions entertained by those who have handed it down. Its importance depends on the suggestion which arises out of it, whether intended or not, that the physical impossibility of a partial deluge is an argument founded on the most ignorant of all preconceptions, and is demonstrably the grossest of all delusions. That there can not have been partial subsidences of the crust of the earth—even on an enormous scale—would indeed be an ignorant proposition, contradicted alike by theory and observation.

But here we come to another branch of the subject, on which, if anywhere, we had a right to expect from Prof. Huxley something better than the most loose and yet the most dogmatic declamation. This branch is that which deals with the actual discoveries of modern science, so far as they bear upon the question. Geology is a science which has made such rapid and enormous progress during a period spanned by the extreme measure of a

* Page 15.

† Kitto's Encylopædia of Biblical Literature, Deluge, p. 243.

single human life, that we are all apt to be a little drunk with our own success. And yet that progress has been marked by incidents which should make us sober. The field, though a small one, on which its victories have been achieved, is strewn with the bodies of the slain. Dead theories and abandoned speculations lie thick upon the ground, while some of the most mischievous preconceptions still encumber the progress of inquiry. One of the first great general conceptions which lifted the speculations of mere cosmogony to the dignity of a science, was the Huttonian theory.* One part of it was securely true. Another part of it was profoundly false. It was true as regards the continuity of causes. It was also as regards the uniformity of their effects. It was true that the rocks have been built up by the interaction of the forces of elevation, and the forces of degradation and depression. It was true that the causes which heaved the hills, have been ever met and checked by causes which wore them down again. But it was not true that the operation of higher laws is never indicated, or that all we can ascertain is limited to a perpetual seesaw of monotonous repetition. As usual, there were many minds which valued the Huttonian theory not for its truths, but mainly for its deficiencies and errors. The school of thought that delights to shut out those fountains of power from which all thought has come, were enchanted with a conception which reduced creation to the dull rounds of mechanical necessity. It was enthusiastic over the famous formula that geology saw "no trace of a beginning, no symptom of an end." In this form it may be called the great hurdy-gurdy theory. Then came the discovery of a clew by which an order of succession could be established in time, and, with time, in the perpetual introduction of new forms of life. Of course the mechanists set to work again, and they are at work still. Lyell supplied them with the only philosophical basis on which they can stand at all, and preached the doctrines of uniformity with immense knowledge and with infinite skill. As in the previous case of the theory of Hutton and of Playfair, much of what he taught was true, while the errors and exaggerations of his teachings are now being gradually but surely left behind. "The bit-by-bit theory of our friend Lyell will never account for all our facts," was the observation made to me one day by Lyell's compatriot, friend, and equal, Sir Roderick Murchison. On this subject happily there is no need of controversy with Prof. Huxley. He has himself taken a creditable part in checking extreme opinions and in showing that the doctrine of uniformity, in the only sense in which it can be rationally held, is quite consistent with any amount of catastrophe and convulsion. In fact, the recur-

* Theory of the Earth, by James Hutton, M. D., 1795.

rence of catastrophe and convulsion may be part and parcel of uniformity itself; and so in like manner, when the speculations of Darwin have furnished the mechanists with renewed passion for a new doll, Prof. Huxley has hoisted more than once a caution signal. He has uttered a warning voice against converting a scientific hypothesis into a dogmatic creed.

It was high time. The passionate enthusiasm with which an obscure and confused verbal metaphor has been accepted as solving all the mysteries involved in the origin of new forms of organic life, will one day be seen to have been—what it is—only another great warning example of the impediments which beset the progress of knowledge. That the origin of species may be ascribed to some thing called "Nature" selecting things which did not as yet exist, and could not therefore have been presented for selection, is among those mysteries of nonsense which are not uncommon in the history of the human mind. But even this delusion, prevalent as it has been, is breaking down, and assaults upon it, all too timid though they be, are nevertheless increasing day by day. I have therefore much sympathy with those who on the whole are reasonably proud of geology as regards its past, and are reasonably hopeful of it as regards its future. But its progress, and even our appreciation of its present teaching, is absolutely dependent on two conditions: first, that we bear constantly in mind the wide seas of ignorance which surround the little islands of our knowledge; and, secondly, that we rightly estimate the full sweep and significance of the facts and laws which we can clearly see. It would be difficult to say whether the science has suffered most from forgetfulness of the things that we do not know, or from failure to appreciate or exhaust the consequences flowing from the things we do know. The vision of past worlds which geology presents may be compared to the view of some land seen at a distance upon the ocean, and upon which heavy banks of cloud are resting. Above, mountains and peaks are seen here and there, with outlines cut clear against the sky. Below, capes and headlands and promontories are also seen, cut as clearly against the sea. The middle slopes are only visible at intervals, and some great plains just roughen the verge of the horizon. But all details are lost. We do not even know whether we are looking at one continuous land or at a group of islands. Hills which seem united, or separated only by some narrow valley, may be really far apart, and broad channels of the deepest water may lie between them. So it is with the vast landscapes of the past in the revelations of geology. The general outlines of geological causation are clear enough; and so in broad outline, too, is the general succession of organic life. But both the exact history of the rocks, and the exact history of the creatures which they entomb, are beset with mystery. We talk glibly of aqueous deposit as the physical origin of stratification; but we know little indeed of the physical conditions under which this agency worked in early times. The scientific naturalists of the Challenger Expedition report as the result of their investigations that nowhere in the existing world of waters have they found going on anywhere such deposits as are necessary to account for the vast massive accumulations of the Palæozoic sandstones.

Before such mountains as those of the Cambrian formation on the northwest coast of Scotland—cut out of the thickness of apparently one continuous deposit—full of the ripple-marks of the sea, and yet destitute of life—the theoretical uniformitarian may well stand abashed. Similar difficulties are crowded into the conditions under which our great storages of carbon were provided for by repeated elevations and depressions of the land, each elevation giving occasion for the growth of a dense and rich vegetation; and each depression potting it up and preserving it for future use. Similar difficulties beset the equally massive limestone formations of the Secondary rocks. But even these difficulties are less serious and less profound than those which beset the progress of organic life. Only, in this case there are some great outlines which are clear and definite. We can see that organic life has advanced from less to more—from low to higher levels—from the generalized to the specialized, and from various functions performed roughly by some one rude and simple mechanism, to the same functions separated, elevated, and committed to the care of selected and adapted organs. We can see how there is some strange but profound analogy between this magnificent line of march and that along which every living creature goes in its individual growth. Just as the science of embryology has in in some measure revealed to us how—that is, in what order—"the bones do grow in the womb of her that is with child," so in the embryology of this planet, as revealed to us in the rocks, we can see the steps of a process which is not only analogous but homologous. That is to say, the two pathways are not only vaguely like each other according to some dim resemblance, but are identical as corresponding parts in one plan, and of one intellectual method. We can see that the past ages were full of prophetic germs. We can see the rise, one after another, of structures which were incipient, useless, or comparatively useless for a time, but destined in the future for some splendid service. Our physiologists, and anatomists, and morphologists are wholly unable to resist this evidence when it is their business to describe the facts. The structure of their own mind compels them to admit it, even when they struggle hard to shut their eyes against it.

Few men have used language more expressive of conceptions which agnosticism repudiates than Prof. Huxley himself in his purely scientific writings. In his descriptions of the growth of living things, from the ovum to the finished creature, we seem to be listening to a literal reading and exposition of some page out of that book in which all "our members were written when as yet there were none of them." It is surely remarkable that Nature should be so full of the spirit and of the characteristic ideas of Hebrew and of Christian theology. But so it is. In Prof. Huxley's instructive work on the Elements of Comparative Anatomy he is rich in the use of language descriptive of the preparations for that which is to be. Every change that arises in the mysterious egg-substance is explained, as it can only be explained, by its relations with the future. Does a movement begin in the formless mass, establishing a long cleft or groove? It indicates the position "of the future longitudinal axis of the body." Do the lateral boundaries of this groove at one end of it "grow up into plates"? It is that this end is the end which "will become" the interior region of the body, and these plates are the "dorsal laminæ." Do these dorsal laminæ at length unite? It is that they may "inclose the future cerebro-spinal cavity." Does another portion of the mass grow downward instead of up? It is that it may "form the vertical laminæ," with a function in the future not less essential.* One thing can only be understood when it is conceived as "laying the foundations" of another.† A second thing can only be understood as "pre-shadowing" the form and relations‡ of a third, and so on throughout. Nor does Prof. Huxley confine this great principle of interpretation to the development of the individual fœtus. This governing idea of referring all organic growth to the work of preparation and prevision, he extends to the whole history of life since it first began. He quotes with approbation, and adopts, the grand generalization of John Hunter, that organization is not the cause of life, but life is the cause of organization. Immense consequences are involved in this conception. Organisms are the habitations and the homes of life, but life must build them before it can settle in them and take possession. An organ is a structure for the discharge of function, but it must be shaped and made before the function can be discharged. This luminous idea sends its searching light through and through the stupidities which confound between things made for use and things that are said to be made by use. Use as an intellectual aim must precede use as a physical cause. And so the prophetic interpretation of fœtal development becomes the only possible interpretation of all organic growth so far as it is known to us. Accordingly, Prof. Huxley interprets the whole his-

* Pages 65, 66. † Page 137. ‡ Page 142.

tory of the vertebrate skeleton, and especially of the vertebrate skull, as the development of a "plan." This is the word he has selected, and which he uses over and over again. A plan—we must repeat—is not a mere pattern, which may arise by accident; it is a construction of which all the leading component elements are parts of one general conception having reference to a future. Such a plan, he tells us, can be traced and identified in all skulls, from the skull of a pike to the cranium of a man. The immense differences which mask this unity of plan are due to successive adaptive modifications, with which, in all their wide extent, the original plan was destined from the very first to work in harmony.

These are grand conceptions. They are scientific conceptions in the highest sense of that word, because they bring phenomena into harmonious relations with the highest faculties of the human mind. They are the conceptions which confer all its dignity and interest on geology, and on the affiliated sciences of paleontology and comparative anatomy. Although in one sense highly ideal, and in the best sense metaphysical, they are yet strictly literal, and absolutely true to fact. Hence Prof. Huxley most truly asserts that the doctrine of "all bony skulls being organized upon a common plan" is a simple generalization of the observed facts of cranial structure.* It is curious that many of those who use these conceptions for the purposes of description immediately turn round and repudiate them for the purposes of philosophy. But the language which embodies them can only be useful for the purposes of explanation by reason of the similitudes which they involve between our own mental operations and those which are obvious in nature. Yet these very similitudes and intellectual homologies are most distasteful to the agnostic school; and very often, even in the mere work of description, every device is resorted to to keep them out of sight. Thus some movements of the nervous and muscular apparatus in animals which involve the most complicated adjustments are constantly spoken of as mere "reflex action"—as if they could be compared with the mere reflection—or bending back—of light from water, or of sound from a wall. So again "differentiation" is perpetually used to describe the processes of preparation by which the building up of special organs is accomplished—just as if these wonderful processes could be described by a word which is equally applicable to the processes of corruption and decay. There is no disloyalty to truth so insidious as that which leads us to sin in this way against our own intellectual integrity. What our mind sees, we must confess to—at our peril. It may have been a brave thing in

* Comparative Anatomy, p. 278.

Nelson to turn his blind eye to the recalling signal of his admiral. But it is not a brave thing—quite the contrary—in any man to turn a blind eye to the instinctive perceptions of his own intelligence.

Nevertheless, it is possible to be true and faithful to the automatic workings of mind within us when it recognizes and identifies the methods of its own vaster image in the external world, and yet to be not less true and faithful to our consciousness of ignorance. The great thing to do is to put our agnosticism not in the wrong but in the right place. We may well rejoice in the clear and grand vision we have obtained through science of organic life having been developed through unnumbered ages on lines which do in themselves constitute a "plan." We may rejoice with the truest intellectual delight in our perception of the relation which this plan bore from the beginning to the future in creation. We may admire without ceasing the combination in this plan between an obvious fundamental unity and a not less obvious fundamental subordination to endless change—wherever new needs had to be met and new functions had to be discharged. All this is science and science of the highest quality; but the sense of it is compatible with a constant remembrance of the enormous gaps in our knowledge which remain unfilled. That which always we are most curious to know remains always also unexplained. Geology has told us of a succession in the forms of life; but it has as yet told us nothing as to the methods by which this succession was brought about. There are, indeed, so-called "links"; but the links are never within each other's touch. The "imperfection of the record" is blamed for this; but there are portions of the record which seem continuous and complete—portions of time which were long enough to see the introduction of new species—and yet the mystery remains unsolved. In the Lias, for example, and in some other formations, we have beds of great thickness following each other in orderly and undisturbed succession. New shells appear in turn, and yet we never see how or whence they came. My friend Mr. Robert Etheridge, F. R. S., F. G. S.,* informs me that there is one bed no thicker than an ordinary mantel-piece in which a peculiar ammonite appears and never appears again. So it is throughout the record wherever it is accessible to us. New forms come like apparitions, and like apparitions they also go. We do not know where such new forms have arisen nor how. We do know that the whole series must have begun somewhere and at some time, in some initial operation which was not that of ordinary generation. We do not know that this initial operation has never been repeated, or,

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if it has been repeated, how often or under what special conditions.

The abstract dicta—the vague verbal propositions—on the strength of which the possibility of this repetition has been denied, are splendid specimens of those cobwebs of the brain which used to entangle thought in the meshes of the scholastic philosophy. The "law of parsimony" is the ambitious phrase under which theorists have hid the stupid notion that what Nature does once she never repeats again, or that results which she has obtained by one method at some one time must never be compassed by the same method again. Hear how magniloquently the great agnostic professor sets forth this marvelous dogma: "If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of living protoplasm should have once appeared upon the globe as the result of no matter what agency. In the eyes of a consistent evolutionist any further independent formation of protoplasm would be sheer waste." * This is very grand. The limitation of the possibilities of creation by the vision of a "consistent evolutionist" is delicious. It reminds one of the American joke that the planets revolve round the sun, "always subject to the Constitootion of the United States." But, unfortunately for the dogma, it renounces the testimony of facts, while sounder reasonings upon them are dead against it. Nature is economical, but she is not miserly. The prodigality of Nature is more conspicuous than her parsimony. The habitual expenditure and repetition of all her processes is at least more clear to us than her refusals to repeat them. Her fondness for identity of principle in all her various operations is more pervading than her casting aside of any method merely because it has been used already. That bits of living protoplasm, with inconceivably complex potentialities within them, should have been called into being once, and that nothing similar should ever have been done again, may possibly be true; but it is not according to analogy and we can not accept it on the authority of Prof. Huxley. Still less can so weighty a conclusion be hung securely on a gossamer structure of abstract and empty words.—*Nineteenth Century.*

Photographs of the annular nebula in Lyra, taken at Algiers, and magnified sixty-four times, give the largest images that have ever been obtained of that object, and make it possible to study the distribution of its light with a precision that has not been heretofore approached. Two very clear maxima of light are observable on opposite sides of the ring of unequal brilliancy. The space within the ring, which is dark to ordinary vision, is found not to be wholly destitute of photographic power. Chemical emanations radiate from it, the existence of which was not suspected before.

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* Encyclopædia Britannica, ninth edition, Biology, p. 689.

SOCIAL CHANGES IN CALIFORNIA.

By CHARLES HOWARD SHINN.

WHEN the Central Pacific Railroad crossed the high Sierras, and the Crockers, Stanfords, and Huntingtons, till then obscure Sacramento merchants, gained the first of their long series of industrial and political victories, a country blacksmith, the late Henry Vrooman, afterward State Senator and one of the greatest party leaders ever known on the Pacific coast, said to me: "That railroad changes forever all the conditions of human existence in California. It will never again be as easy to live here."

A thousand times since, events have shown that the gold-miners' El Dorado of 1849, which had become as different from the rest of the United States as South Carolina is from Massachusetts, was readjusting itself to new conditions imposed by the iron links that bound it to the Atlantic slope and the valley of the Mississippi. At first the change was slow and almost unnoticed. Until the close of the war, prices, rates of wages, and the general conditions of life in California, Oregon, Washington, and Nevada remained practically the same as before. Arizona was then but a frontier outpost, and men like Mowry were holding mines with rifle and revolver against the unconquered Apaches. The whole Pacific coast, from the borders of Mexico to Puget Sound, was still forming its own social customs and creating, as did the South, its own literature. The decade of railroad-building was also the decade of the foundation of State universities, magazines, art-schools, and libraries, and, to a remarkable degree, the decade of the beginnings of many private fortunes in mines, commerce, and real estate.

Early conditions of life in California were unusual in the wide range of opportunities offered to men of strong tenacity of purpose. Nearly every one could make money, and a great deal of it, in the decade between 1849 and 1859, but the temptations to spend were enormous. Illustrations of this are usually drawn from the mines, but some of the most characteristic stories come from other sources. In 1853 there were half a dozen men who shot wild fowl and other game in Contra Costa for the San Francisco markets. They could earn fifteen or twenty dollars apiece every day for nine months of the year. One of them saved his money and bought land for a dollar and a quarter an acre that is now covered with buildings; but the rest are forgotten characters, except for a few sentences in the local chronicles respecting their notable bags of game.

Numberless were the contrasts between California life at that period and life anywhere else in the country. Ordinary economic conditions were for a time suspended. Gold was the chief crop of the State, and gold was gold everywhere. The merchants who wanted to make a "corner" in any product need only "corral" all there was of that commodity in California to be safe for days or weeks. Steamers went twice a month to Panama, and the pony express crossed the continent; but we had no telegraph and no railroad, and immigration, after the close of the great gold-rush, was comparatively small and steady. In the midst of this isolation a community developed in which every man of any strength or purpose soon knew and was known to every other man of ability. Thus, in the old mining towns, like Placerville, Grass Valley, Oroville, Shasta, and early valley towns such as Stockton, Marysville, and Sacramento, and coast cities such as San Diego, Los Angeles, San Francisco, and Eureka, and in the hundreds of country neighborhoods, where ex-miners became owners of herds and growers of wheat, isolation produced strong individualism.

The Californian not only gave up his Eastern newspapers, but his Eastern weeklies and monthlies. Cities of the same population as the San Francisco of 1850–'60 seldom have half so long a list of publications. Many of these were illustrated by the drawings of artists like Keith and Nahl. Men drew and painted, etched and engraved, wrote and spoke, for the busy, energetic people of the lands west of the Sierra Nevada. No other audience was possible; no broader field was desired. As the Virginians and the North Carolinians, climbing the Blue Ridge and settling on the lands that slope to the Mississippi and the Ohio, became Kentuckians and Tennesseeans in a single generation, so the pioneer men and women from every State of the Union that settled on the Pacific coast became Oregonians and Californians, and founded two as distinct commonwealths as there are in America.

The literary field to which I have alluded is fruitful in illustration. California, before the walls were fairly broken down, had half a dozen weeklies, none of which now remain. They were circulated in every mining camp, some printing ten or twelve thousand copies, and among their writers were Bret Harte, Mark Twain, Noah Brooks, George Frederic Parsons, Ina D. Coolbrith, and such a group of literary men and women as no American city outside of Boston and New York could gather together at that period. A monthly magazine was established, which in a few years gained a circulation of eight thousand copies, and made the reputations of a host of writers. As the sharp pressure of outside competition began to be felt, all or nearly all the literary journals of California rapidly deteriorated in quality, as they lost home support, and they either suspended or became mere advertising publications. Conditions of literary life in California changed during the decade that witnessed the driving of the last spike of the first railroad across the continent. Most of the writers who had earnéd reputations went elsewhere, and those who stayed became more and more conscious of the fact that they also should have gone. It is not too much to say that along in the early seventies, Californians, always a reading people, became thoroughly aware of the existence of the publications of the rest of the United States. After the crash that followed, when every local journal felt for the first time the competition that a daily mail implies, a few single-hearted men and women revived the magazine, and an entirely different line of weekly publications was established. The old journals had no models, and practically recognized nothing ouside of "the coast"; the new journals, far less original, and developing as yet no writers of national reputation, have become better established financially, and depend considerably upon a circulation in other parts of the country. The chief characteristic of most of them, however, is an exaggerated dread of being considered "provincial," and one can not gratify them more than by praising the "Parisian style" of their local epigrams and illustrations.

The first literature of California was purely American in its best features, and accurately reflected the frank egotism and splendid energy of the young commonwealth, that had as yet felt little or none of the life-struggle in which the rest of the world was engaged. But when the stress came, and the land of ease and plenty, high wages, large profits, and abundant comfort knew hard times, the only book of the era was Progress and Poverty. Luck of Roaring Camps, Big Jack Smalls, and similarly picturesque studies born of the mingling of Russian, Spanish, and American currents, could no more be written in California. The "Great Bonanza" period came and went; the new Constitution agitation, Kearney's sand-lotters, McGlashan's anti-Chinese boycotters, were chapters in the State's history, but no representative book, except George's Progress and Poverty, came to the surface, though the raw materials of half a dozen novels were contained in this transition era. Instead of crystallizing into permanent literary form, the agitation caused by new economic conditions became chiefly political.

During the period of revolt and uncertainty, business suffered, speculation increased, and many men withdrew capital from California. The railroad-builders had brought the State into the general order of things, and life on the old scheme had become impossible, though the war, the clinging of Californians to gold values, and the development of the Comstock, long prevented the popular recognition of the gravity of the problem. When knowledge came, it came swiftly and bitterly. Workingmen who had been earning five or six dollars a day, found, in three or four years, that their wages were forty per cent lower. They felt Chinese competition far more, and other laborers were coming in. The farmers found the price of wheat falling, and ships leaving the coast because of railroad competition, so that freights rose. The merchants found the area of tributary country diminished by the creation of other commercial centers. California suffered more in the necessary readjustment than did any other part of the Pacific coast, because its growth had been much more rapid, its resources had been larger, and it had had, in the historic sense, a far more educating environment. The commonwealth of California was not merely the colony of gold-seekers of '49; it was, in the broader view, the result of American energy working upon the old foundations laid by Spanish pioneers of the eighteenth century; it had its missions and its olive groves before the American Declaration of Independence, when all the rest of the Pacific coast was an unknown wilderness. It could not be otherwise than that the change in economic conditions struck to the heart of Californian life, and seemed for a few years to have produced the disaster of a permanent descent to lower ideals.

"Californians," said a brilliant newspaper man to me during that period, "were once the most magnificently liberal race of men on earth; now they have determined to become the most miserly. Once they talked of endowing a university with twenty million dollars; now they have let President Gilman leave them and go to Baltimore. Once they were proud of everything Californian; now they want a foreign trade-mark on everything."

During the period that I have called the transition era, extending over eight or ten years after 1870, political standards in California were lowered to an extent, in both kind and degree, which is difficult to explain, and which has hardly changed since, except for the worse. All the links and fetters of party allegiance were more tightly drawn. The rule of the purse was more and more pre-eminent in every campaign, and no party or faction long resisted temptation. An almost unbroken line of demagogues, numbered and branded by political bosses, and divided with amusing evenness between the Democrats and the Republicans, misruled the State and increased the expenses of government. The lowering of the remarkably advantageous economic conditions of a quarter of a century ago appears to have thrown many unthinking voters into closer relations with "the bosses," and so has made honest politics a more difficult business. It is the most deplorable result of that sudden outbreak of discontent called Kearneyism, that a lower, more mercenary political order still prevails. Reform rests with the young men, who are organizing, regardless of party, to work for the purification of politics, and with a new conservative class—the horticulturists.

Stanford's railroad-builders, breaking down the mountain walls, so that the world-spirit surged in, opened the way for new industries, and the same chain of circumstances that delayed the Californian's realization of the end of his Utopia allowed the firm establishment of a vast group of occupations before impossible. Foremost of these was that varied and profitable industry which some have called "intensive horticulture"—the industry that makes an acre produce more food value than a hundred acres of wheat or corn. California made a new start, and escaped industrial ruin, chiefly by reason of vineyards, gardens, orchards, seed-farms, hop-yards, and the whole group of allied pursuits. These industries educated a great number of cattle-raisers and wheat farmers, supplemented by clerks and mechanics with their small savings, into horticulturists. Thus California obtained a new and very valuable class of conservative citizens, well out of debt, and more intelligent than the ordinary farmer. The movement toward horticulture, as a business, began when the Central Pacific was completed, and went on steadily through all the years of ferment. It was the most hopeful movement of the time, for it built up the interior of the State, it broke up the great stock-ranges and wheat ranches, and it promised to restore to California far more than had been lost. As soon as horticulture became established as the great future industry of the State, an era of immigration began, first in southern California, then over the whole region. The inevitable readjustment of forces and shifting of industrial centers followed, and is still in progress.

For fifty years to come horticultural interests will probably increase, and among horticulturists the skilled fruit-grower, owning from ten to fifty acres of land, will best represent his class. Such a person is likely to be more of a business man than the average farmer, and is in closer relations to town and city life. He is compelled to travel more, watches the markets and the fields of invention closer, and represents, all in all, a finer type. A California fruit-grower is in some respects akin to the middle class of suburban dwellers near Boston and New York, with this very important difference, that he actually and constantly makes his living from the soil he owns. The one tendency of his life is toward what may be termed "extreme Californianism," for he is growing almonds or oranges or something or other that can not be produced at a profit in many other places on the continent, and the "glorious climate" is his best friend. But, on the other hand, he is in a skilled business, full of technical details, requiring plenty of brain-work, and he is selling in the world's markets. Many a California grower of raisins, oranges, walnuts, olives, prunes, or other horticultural products goes to Chicago and New York every autumn, "to keep the run of the field." The drift of Pacific coast life is toward a rapid increase of the number of orchardists. They are organized, too, in a manner unknown among the farmers, and have several times shown unsuspected courage in independent politics. Some of these days professional politicians will have to deal with a new factor—the horticulturist, a distinct evolution from the conservative American farmer type, quicker of brain, less wedded to party bonds, and more capable of understanding the interests of the commonwealth.

This rapid review of some important economic changes of the past fifty years leads naturally to the consideration of the present conditions of life in California. Wages are still high, and all classes of workers should be prosperous. The resources of the State are being developed at a marvelous rate. In 1880 the population of California was 864,000, and the assessed value of all the property in the State was $564,578,036. "Assessed value," in California, means "that amount which the property would bring at a forced sale." In January, 1890, the estimated population was 1,465,000, and the assessed value of property was $1,112,000,000. The deposits in the savings-banks averaged over $87,000,000, and were widely distributed. The assessors' returns for the counties show that lands in city and country, and their improvements, are well divided up among the people, and California is becoming a State of moderate-sized farms and fair but not large incomes.

The wages of ordinary farm hands in California range from twenty-five to thirty-five dollars a month, usually with board. Portuguese, who are already the peasantry of the rich valleys near the bay of San Francisco, expect from twenty-six to thirty dollars, and board themselves. They own small tracts of a few acres, "work out" most of the time, and are a fairly capable though slow class of laborers. Chinese, who are expert in garden and orchard work, are paid the same as the Portuguese. Italians in the vineyards rate at about thirty-five dollars, and board themselves. Skilled labor in some departments of farm and orchard work commands forty or forty-five dollars a month. Pruners, grafters, fruit-packers, teamsters, obtain such wages, and in the lumber districts Americans often get fifty dollars. Commissioner Tobin's report for 1887–'88 gives the statistics of wages paid in California and other places, and a few comparisons with New York wages will serve to illustrate the subject. California bricklayers rate at thirty dollars a week as against twenty dollars in New York; carpenters, twenty-one dollars as against fourteen; masons, thirty dollars as against eighteen; blacksmiths, twenty-one dollars as against thirteen; draymen, fifteen dollars as against ten; gardeners, eighteen dollars as against nine.

The cost of clothing in California is about ten per cent higher than in the Atlantic States, but the California workman is apt to wear better clothes. The average cost of food is estimated to be higher in California, but the California workman lives better. The cheap restaurants of San Francisco are superior to any in Eastern cities, and one can live there at less expense, or get more for his money, whichever he chooses. Owing to the climate, incidental expenses can be made less in California, and no time need be lost from one year's end to another. Lots are still cheap, and wood, the great building material, is about one third lower than in New York city.

Favorable as are the conditions outlined, the chief advantages are obtained by men. The wages paid to women for manual labor do not compare favorably with Eastern rates. The seamstress is no better off in California than in New York. Men proof-readers receive eighteen dollars a week, while women get nine dollars; men glove-makers are paid twenty or twenty-five dollars, while women have from five to ten dollars; salesmen in stores receive from fifty to a hundred dollars a month, while saleswomen are rated at from twenty to forty dollars. This difference comes partly from the fact that Chinese competition has been especially strong in domestic occupations. As regards teachers, the school law of California says, "Females employed as teachers in the public schools shall in all cases receive the same compensation as is allowed male teachers for like services, when holding the same certificates." In San Francisco the average salary paid to women teachers is $75.16 per month for twelve months. The statistics of the Labor Bureau bring out many encouraging facts about the life of the laboring women of San Francisco. These women number about twenty thousand, engaged in some three hundred occupations. The general condition of the establishments where they are employed is better than in some classes of establishments in the Eastern States, and the hours are shorter. Several "sweaters' shops" have been investigated, and public feeling aroused. In some of the cigar-factories and canneries Chinamen and American girls were found working together, and a law will probably be passed to prevent this. A "workshop and factory inspector," to operate under some general laws such as those of Massachusetts, is needed. The most satisfactory point about the condition of California working girls is the extent to which they "live at home." The tenement-house system has not yet reached San Francisco. With few exceptions the homes of the working women are neat and comfortable. In the interior towns work-girls are paid better, as a rule, than in San Francisco. The growth of horticultural industries has made so many demands for work-girls in the country that the factory system can not be established in California for years to come.

Many California women are making horticultural ventures. Teachers, clerks, type-writers, and saleswomen seem particularly apt to buy land and plant vines or trees. An association of about a hundred women are becoming florists. Another group is interested in *buhach*, the Persian insect-powder plant. Within a hundred miles of San Francisco the conditions necessary to the successful culture of leading fruits can be obtained. The extent to which women are turning their attention to this field is noteworthy, and must prove one of the important elements in the organization of the "coming California." One finds women directing outdoor operations in every part of the State, and several of the largest orchards are owned and superintended by women.

Labor organizations are strong in California, containing about thirty thousand wage-earners, and collecting over $100,000 a year in dues in San Francisco alone. The trades-unions of San Francisco and vicinity have twenty thousand members. Hours of labor among unorganized classes of workmen range from twelve to sixteen, among the organized classes from eight to ten. In the matter of strikes the trades-unions have sometimes been difficult to control, reckless and dangerous, especially during the "period of transition." Between 1880 and 1886 there were one hundred and seven strikes in California, affecting 6,763 men and women, and losing 1,508 working days, at a cost of $324,639 to the strikers and $311,093 to the employers. Seventy-seven of them succeeded. There were nine lock-outs, all but one among the cigar-manufacturers. Since 1886 the number of strikes and lock-outs has diminished by one half. The largest ones have been in the foundries and iron-works, those industries being in a state of depression. Public sympathy has been with the employers in most of the recent strikes, as the favorable conditions of workingmen in California are well understood.

The Chinese problem, so called, has but little vitality, although it is still a fruitful subject for newspaper editorials and sensational space-writing. The masses of Californians appear to think that the present laws are reasonably well enforced. Orchard and vineyard extensions may cause such a demand for "cheap labor" that the farmers and orchardists, who have hitherto depended a great deal upon Chinese, will form a pro-Chinese party. It was the fruit-growers as a class that broke up and defeated the Chinese boycott in California a few years ago. The ground they take is that they prefer white labor, but they will not see their crops lost when Chinese can be had, and they will not allow any dictation from trades-unions or boycotters. The Chinese now in California have been greatly benefited by the Exclusion Act. They receive better wages than before, and in many cases better treatment. The more enterprising among them show a tendency to become land-renters, and in a few instances land-owners. A Chinaman's point of view is about this: that the soil, climate, and opportunities of California suit him, and a "dollar and a quarter a day" is as much of a bonanza to him as the "sixteen-dollar-a-day diggings" were to the American Argonauts of 1849. He will stay as long as he can get his wages, and, if the Exclusion Act is strictly enforced, the chances are that his earnings will continue to increase. He has trades-unions of his own, and whenever it appears judicious, he strikes for higher wages and usually gets them. The laws that protect him against the competition of other workers of his own race are exactly to his mind.

Speculation in California has taken a turn of late years. Few persons invest in mining stocks any more, and there are not many other speculative securities. The glories of Pine Street and Pauper Alley have departed. Wealthy men who used to gamble in "stocks" now buy mines instead. Twenty or thirty California operators, who have left the street, have agents and experts visiting every camp from Sonora to Alaska, and the actual mine-workers have gradually secured nearly all the valuable properties of the coast. Speculation in real estate has become the form of investment among the poorer and middle classes. Town lots in new towns have had their day, and acreage now "takes the call." Over whole counties the farmers and fruit-growers are mortgaging lands to buy more lands, believing that they never will be so cheap again. The rule of the wheat-grower is that thirty dollars an acre is as much as he can afford to pay, and ten or twelve dollars is nearer the average cost of the grazing lands now changing to wheat. The rule of the fruit-grower is that he must have only the land that is exactly suited to the business, and he can pay from fifty to two hundred dollars an acre for such land, provided he has capital to plant it at once.

Books of California travel, with hardly an exception, lay stress on the restlessness of life here. "The whole State is for sale" is a commonplace of the tourist. But the average Californian farmer, instead of being a speculator, is as tenacious a land-holder as a Pennsylvania Dutchman. During the whole land speculation period in southern California, hundreds of Los Angeles County ranchers went on raising corn and potatoes as calmly as if the excitement had been a thousand miles away. There are large and fertile counties where nearly every farm for miles along the highways is owned by the man who "took it up in the fifties," or is divided among his children. There are rich valley townships where hardly three land transfers take place in a year. The old Missourian settlers are slow to sell or change, but equally slow to improve. New England settlers never sell, but extend their acres if a chance offers. The Western "hustlers," and men from the cities, are the ones that lay out new towns and colonies where immigrants can buy ten or twenty acre tracts. Instead of California being a land of rapid changes in land-ownership, it is, on the whole, very conservative in this respect. The large ranches are for sale, but the homesteads are not.

The middle classes of California will always draw their living from the soil. Mining and lumbering require more capital, and manufacturing will not develop to any great extent for many years to come. The products of which the State appears to have a natural monopoly promise to support a dense population, spread over the country in colonies, on small farms, and in loosely built towns. No other part of the United States is developing under similar conditions, and hence the economic history of California has the importance of a new experiment. Wages still high, a generous scale of living, few manufactures, industries largely horticultural, tendencies which rapidly change the better classes of workmen into small land-owners—such are the conditions. What sort of a community will the California of the twentieth century be?

Dr. HENRY T. SCHLIEMANN.

DR. HEINRICH T. SCHLIEMANN, the enthusiastic excavator of the most ancient Grecian cities, died in Naples, Italy, December 26, 1890. He was born January 6, 1822, at Neu Buckow, Mecklenburg-Schwerin, where his father was a Protestant clergyman, poor, but interested in ancient history, and particularly in the excavations at Herculaneum and Pompeii, which were then fresh. Acquiring some taste in these matters and a little knowledge of Latin from his father, young Schliemann's interest in Troy was aroused when he was seven years old by the sight of a sensational picture. in Dr. Georg Ludwig Jerrer's Universal History, of the burning of that city. The book, according to Dr. Irving J. Manatt, in the Independent, is still treasured in Schliemann's library at Athens, and in it, the writer adds, "he has pointed out to me the rude picture of Troy in flames, the sight of which first lodged the seed-thought in his soul." He decided at once that the foundations of such a city must still exist, "covered up by the dust of ages," and determined to make their discovery the purpose of his life. To this determination he adhered through all the vicissitudes of a precarious career. After some four years at the Gymnasium and the Realschule, he was apprenticed in 1836 to a grocer in Fürstenberg, where he worked for five years from five o'clock in the morning till eleven at night on a maximum yearly salary of thirty dollars. He was able to gratify his archæological tastes in this situation by hiring a drunken but learned miller's clerk to recite to him lines from Homer. One day he broke a blood-vessel while trying to lift a barrel, and was discharged as no longer of value to his employer. Utterly destitute, he took passage in a vessel for South America, was shipwrecked, found his way to Amsterdam, and obtained a light employment, in connection with which he was able to read a little every day. He thus gradually acquired a good knowledge of English, Dutch, Spanish, Italian, and Portuguese. In 1844 he entered the office of Messrs. Schröder & Co. on a comfortable salary and began to learn Russian, preparatory to taking an agency for the house in St. Petersburg. He soon started in business in that place on his own account. In 1850 he came to California, where he became an American citizen and the possessor of $400,000. He returned to Russia, continued his business, and learned Swedish and Polish. After the Crimean War he learned Greek and then devoted two years to the study of Greek literature. In 1858 he traveled through northern Europe, Italy, Egypt, and the lands of ancient Greece. Being compelled by a lawsuit to return to Russia and stay there three years, he went into business again and made more money. Before beginning his life-work, for which the opportunity at last offered, he made a voyage around the world and published his first book, La Chine et le Japon, in 1866. Having dug experimentally, without important results, at Ithaca, he began in 1870 his excavations in the Troad to verify the accuracy of Homer's account of the lost Troy, in the literal reality of every part of which he fully believed. He began first at the place called Bounarbashi, which the learned world had agreed was the site of the ancient city. Having dug and examined the topography long enough to satisfy himself that nothing was to be found there, he tried the mound of Hissarlik. Here he unearthed six cities which had succeeded each other on the same site, four of them at least prehistoric, and one of which, bearing the marks of a great conflagration and being rich in relics, he was satisfied was Homer's Troy. For security in performing this work, Dr. Manatt tells us: "As an American citizen he took out our passports for himself, his family, and his servants; and it may as well be remembered that Troy was uncovered under the protection of our flag." The results of these explorations were described in the books Troy and its Remains, and Ilios, the appearance of which was the signal for an active discussion of the merits of his discoveries. While many doubted the accuracy of his identification of one of the cities with the real Troy, it was generally agreed that he had found something remarkably interesting and important, as well as very ancient, and that possibly the real Troy was somewhere in the heap. Convincing testimony to the value of the investigation was given by Dr. Virchow, who visited the place and examined it, and by a commission of archæologists, who made a special report upon the subject. Dr. Schliemann next turned his attention to Mycenæ, the capital of Agamemnon and the kings of the house of Atreus. Following the directions of Pausanias, he selected a spot, dug, and found, if not the tombs and the treasury of the Atridæ, five tombs of royal rank, with sarcophagi and death-masks, and a treasure-chamber, which he decided to be of equal age. Dr. Manatt says that when the first skeleton came to light in these royal tombs, "he fell upon his knees before it, exclaiming, 'Thus have I imagined my hero!'" The results of this work were described and published in another splendid book on Mycenæ and Tiryns. He next excavated Tiryns, which he had already partly explored and described in connection with his work at Mycenæ, and laid bare the walls and a prehistoric palace and citadel, with the gates, court-yard, hall, chambers, and bath-room. Another volume, corresponding in style with the previous ones, was devoted to the discoveries made here. Dr. Schliemann subsequently made excavations at Orchomenos, the mound of Marathon, and other important ancient sites, and was contemplating further work of a similar character. The value and accuracy of his discoveries have been subjected to unfriendly criticism and much active discussion; but, while he could not prove that the second prehistoric city at Hissarlik was identical with Troy itself, or that the tombs and treasures at Mycenæ actually belonged to the Agamemnon who was murdered by Ægisthus, he was able to repel all efforts to discredit the results he got, and to convince the most accomplished antiquaries and archæologists that, if not these, he had found something very like and very near in time to them. Every kind of hypothesis was tried, as the Saturday Review says, by those who doubted the genuineness of the discovery of Mycenæ, "but only Dr. Schliemann's fitted the case. The bronze blades of the poniards, when the patina was removed, were found to be beautifully chased in various-colored gold, such as Homer describes, with scenes of war and the chase. The art was clearly inspired by Egyptian reminiscences: here were men hunting wild ducks, for example, in a papyrus marsh; here were pictures of such huge shields as Homer attributes to his heroes. The figures, on the other hand, were far more free in execution than those of the earliest known Greek art. In brief, new materials and a new problem were offered to archæology, and the evidence of tradition was once more proved to be more trustworthy than any one had expected." The grandeur of this discovery, indeed, furnished the chief doubt of the validity of the identification of Troy, for "if Mycenæ were so great and strong, why did it need all the power of Achaia to overthrow the little village of Ilios?" His wife, a well-educated Grecian lady who shared his Homeric enthusiasm, assisted him with her sympathy and co-operation in a large part of his researches. Dr. Schliemann's death followed a cold contracted after undergoing a successful surgical operation for deafness at Halle. He tarried for business on his way home, and, failing to take the care of himself

HENRY T. SCHLIEMANN.

which he needed and which prudence should have demanded, caught a severe cold, and had stopped at Naples for treatment. His enthusiasm in archæology and his example have been the inspiration of many, and have provoked the organization of societies in England, Germany, France, the United States, Greece itself, and other countries, for the exploration and excavation of the ancient Grecian sites. The enthusiasm, which carried him through all his life-work and permeated even his commonplace occupations and his amusements, was illustrated in his custom of giving Homeric names to all who came into his household. "Among his busy servitors," says Dr. Manatt, "were Æneas and Creusa; Bellerophon was his porter and Priam kept his garden, Circe and Electra were his handmaids. No matter what name one brought into his service, the chrism of the Hall of Troy made all heroic. His own children were Andromache and Agamemnon from their birth—for short, Andromachidion and Agamemnonidion." When Dr. Manatt, accompanied by his daughter of seventeen, first visited him, he at once gave her a Greek name—Artemis—and that she remained to him to the last. At the first breakfast, "Artemis was installed in the place of the mistress of the mansion, and received the homage due to her illustrious new name."

Dr. Schliemann made his permanent residence at Athens, where he built a fine house which is styled a palace. Here, in the midst of trophies which he had recovered from the ancient world and "muniments of the world's honors," he led a methodical working life. "Hours before the Attic dawn, winter and summer, daily he was at the Phaleron for his plunge in the divine sea; all day long the busy work went on; and late into the night the lamp burned in the study that looks over the city upon the Acropolis." From any of his occupations he would turn to meet and entertain a visitor, and he was at home "of all men the most accessible." He dispensed a liberal hospitality, and on festival occasions his house was thronged by the best—the select of Athens and strangers. His business interests were never allowed to suffer. He had valuable investments in many countries, and they were all profitable; and he could find himself familiar at any moment with the details of their condition and management. His funeral was honored with testimonials from the Emperor of Germany, from the city of Berlin—which had honored him with the distinction shared only by Bismarck and Von Moltke, of making him one of its Ehrenbürger—and from numerous learned men and learned bodies, and by the personal attendance of the King and Crown Prince of Greece.

THE BADGER AND THE FOX.

Of the few animals which now inhabit the woods and the hillsides, perhaps the badger is the least known to the general public. He is nocturnal, in the first place; and his coloring, being in broken tones, does not readily arrest the eye. His head, chin, and neck are white, with brownish-black bands running on either side from the nose over the eyes and ears. His upper parts are light-gray sprinkled with black, the lower parts brownish black; his fore feet are long and stout, his limbs muscular, his jaw powerful, and his teeth sharp; in fact, he is well set up as far as these formidable weapons are concerned. The usual length of the animal is a little over three feet, but in his family, as well as in the human race, there are large and small individuals. Take his general appearance as he jogs along, and a small bear is at once suggested to your mind. Many of his ways, too, are bear-like; he will lie up in the winter, and eat vegetable as well as animal food. Some other creatures, that are supposed to be strictly carnivorous, will eat fruit when they can get it.

The badger, poor beast! is getting scarce; more's the pity, from the animal collector's and the naturalist's point of view. He generally manages to dispense with the observation of the latter; for, unless his ways are well known, he will escape from a place that might have been supposed strong enough to hold a rhinoceros. All his family have been excavators from the beginning, on the most scientific principles. Unless you take the greatest precautions, he will dig himself out and get away in quick time. He is a most quiet and orderly being, and a contented one too, if let alone; for, as a rule, he is fat.

His persecutors are many, from the keeper down to the rat-catcher's lad, who boasts that he has "the best dog at any varmint as ever run on four legs." Some of our common expressions require alteration, being founded on ignorance. For instance, folks say, "Dirty as a badger"; whereas a cleaner creature in its home and surroundings would be hard to find. A very wide-awake individual he is; and he needs be, for the hand of both man and of boy is against him, and utterly without reason.

If the badger had but the same privileges extended to him that the fox has, he would not be so rare an animal as he is now. Why should he be so worried by dogs? It is to be hoped that badger-drawing has nearly had its day. This very practice, brutal as it is, testifies to his determined courage and fighting qualities; you could not find a more determined antagonist than he is when on his mettle.

With regard to his food, the greater part of it consists of such small deer as may fall in his way, when he wanders here and there in the evening after leaving the hole where he has lain dormant all the day. That long snout of his will poke and root out all manner of things, from a wild bees' nest to a field-mouse. He will eat young rabbits when he can get them, and old ones do not come amiss to him when the chance offers. A sporting character I knew once procured a fine badger for the express purpose of having him baited by all the fancy dogs in his locality. Among other creatures he kept rabbits, and his particular fancy was to have the very best of the lop-eared variety that could be procured. One doe he valued most highly, because, setting aside her own qualities, she had a fine lot of young ones, well grown, and as beautiful as herself.

The badger had only been caught the same evening on which it was brought to this individual. Not having a place ready for it, he placed it for the time in an empty hutch just over the one in which his favorite doe and her little ones were. Fastening the door securely, he left the animal to his own devices for the night, little thinking what these might be. Next morning he found, to his horror, that the badger had torn up the floor of the hutch where he had been placed, and got into that of the doe, where he had slaughtered the whole family. Their bodies lay dead there, the badger curled up in the middle of them, fast asleep, and very full of rabbit. His first impulse was to kill the beast, there and then, but on thinking it over he remembered that he had paid a considerable figure for it; so he got the badger out and sold him to one of his friends as a pet, telling him that it was "quite harm-

THE BADGER.

less, would live on bread and milk, and in a very short time would follow him about like a dog." Very soon, indeed, he was requested by this friend to take him back again, but he refused.

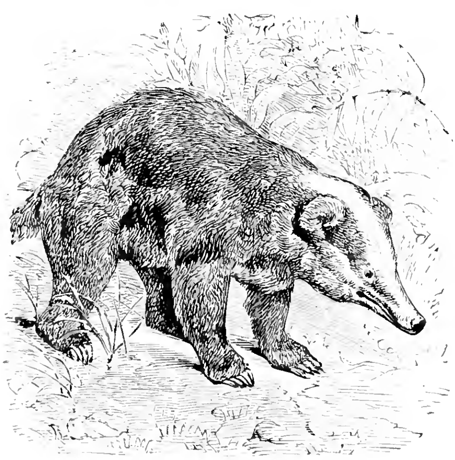
I will describe one of his homes, which I have visited many times. At the bottom of a glade, by the side of the chalk hill, is a dip or hollow, not deep, but a kind of basin about twice the size of one of my living-rooms. Round this, old beeches, growing close by, have pushed forth their great roots in all directions; on one side of the hollow a gnarled oak stands, not any great height, but of vast bulk, the great limbs reaching far over the open space. In the middle of the hollow, under the roots of this oak, our friar of orders gray has made his home, and a very secure and pleasant one it is.

When the moon is high up in the sky, and throws a soft silvery blue tone on the tops of the firs which line the side of the glade, the glade itself showing like a bright blue-green stripe, and nothing is heard but the jar of the fern-owl as he flits over the glade, or the drone of some beetle as he flies along, then is the time for our friend the badger to come out and see how the world looks in the moonlight.

He has left his hole, and there he stands in the full light of the moon, the great limbs of the oak throwing checkered shadows around him on the greensward and on the exposed surface of the chalk here and there. The greater portion of the sides of the hollow nearest his home is covered with foxgloves and trailing bramble. He looks round about him for a few seconds, and sniffs, just to find out if anything peculiar is in the air; then, finding matters all right, as he thinks, he gives himself a scratch or two and a good shake, and deliberately waddles off to get something to eat—a very easy matter at this time of the year, for on a warm summer night all kinds of creatures are about, and he makes their acquaintance much to his own satisfaction, if not to theirs.

Little does he think that he is wanted on this particular evening. While he goes plodding along, picking up a little bit here and there, the keeper and his lad are holding some conversation about him. I happen to come across them; my sympathies are with the badger, but it is not my business to interfere.

"Have ye got the bag and sack, Jim? If ye have, jest make yer way, quiet like, over t'other hill, an' cum down the side on it, on the quiet, mind; fix yer bag, an' when 'tis done, give three hoots, one arter t'other, to let me know as things is all right; ye minds what I tell ye; I'm goin' back to git Ginger an' Nipper. They'll hussle him up, an' no mistake. They ain't big uns, but better tarriers than what they be never cum inter this 'ere wurld. Now then, off ye goes, an' before ye gits yer job done I shall be near to ye, fur to hear ye hoot: he's sartin sure to be on the ramble."

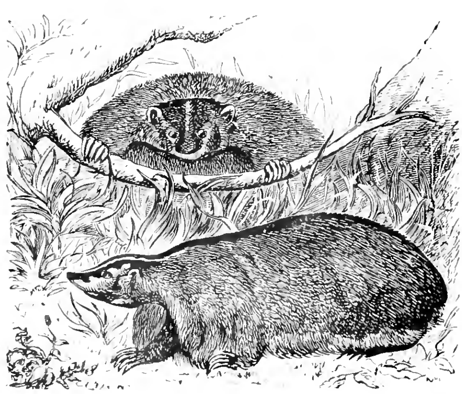


Indian Badger.

Arriving at the spot, Jim produces the bag, or rather a small sack, from his jacket pocket, and places it in the entrance to the badger's burrow in such a way that should the animal rush for home, as he generally does when alarmed, he will go right into it. The string that runs round the mouth of the sack will be pulled tight by the force of his rush, and there he will be like a pig in a poke. The string of the bag is secured, of course, to a peg. Having arranged all this to his own satisfaction, Jim picks up the large sack—he had two, a large and a small—walks out of the hollow on to the moonlit greensward, and hoots like a brown owl, three times. After this musical effort he stands quite still, and listens intently, but for some time the humming jar of the fern-owl, chur-chur-er-er-er-er-chur, is the only sound that reaches his ear. Suddenly he places his empty sack on the ground beside him, and is on the alert, for a sound of quickly moving feet at a distance makes itself heard. He knows what that means: Ginger and Nipper are close on the badger's track; and like the well-bred, well-trained little fox terriers that they are, they run him mute, save for the mere ghost of a whimper now and again, just enough to show they are eager to close with the poor beast.

That, however, is far from the keeper's intention; he would not let his two little beauties, game though they are, close with such a desperate antagonist as an old dog badger, if he could help it; for he knows well enough that dogs and badger would fight to the death. His plan is that they shall drive him to his burrow, and into the sack.

The best-laid plans do not succeed always, however, as is proved in this case. Nearer and nearer comes the sound of pattering feet at full speed, and behind that the heavy tread of a man who is putting his best foot foremost. Nearer they come; they will break into the moonlight in another moment; we can hear them pant, for they have run him through the cover at top speed. The lad is ready to dash down into the hollow; in fact, he has already moved to do so, when the sound of running feet stops dead; and then, in the thicket, a desperate tearing scuffle is heard going on, for Ginger and Nipper have run into and closed with him before he could reach home.



American Badger.

The sounds make Jim wild with excitement, and he shouts his loudest to the keeper, who is now close at hand and puffing like a steam-engine with running so hard.

"Can't ye git a badger in a sack without hollerin' like murder?" he asks angrily. "I'm a good mind—'.

What he'd a good mind to did not transpire, for the boy yelled out: "I ain't got him; they'se got him; don't ye hear 'em worryin' of him?"

Making use of some very strong expressions, such as he would not make use of at a chapel tea-meeting, the keeper dashes into the thicket, followed by Jim; quickly they reach the spot, where they see a confused mass of living matter, turning and twisting, growling, whining, and snapping, at their feet.

"I'll murder ye, you old varmint!—Look out, Jim! Cuss an' hang him! I can't git a stroke at him! Why the —— here they are; what's up now? Ginger! Gin r! loose him! Ginger! he'll rip ye up in bits. Let me smas im!"

"Here he is; hold hard, master! ye nearly had 'im; hold hard!"

"Well, if ever I take my tarriers! Oh dear! oh dear! if there ain't Nipper; he's done for. Hold him, Jim; don't ye let him out o' yer arms, for mercy sake. Now, then, here they are; now fur it, one way or t'other. This is the wust night's work as ever I come across. Jim! Jim! where be ye?"

"In this 'ere tangle; I'm comin' fast as I can."

"Have ye got Nipper?"

"Yes, I got un."

"He's a dunner, ain't he?"

"No, he ain't; it's tight work fur me to hold him!"

"Don't ye let him go; here they be, dead as herrins! Oh dear, Ginger! if I ain't wound up clean! Never agin will I see your feller. If it waunt fur the shame on it, I could fairly beller! I be cut up, an' no mistake."

"Pick him up, master! you'll hev to loose his holt, for dead as he be he's got him under the ear. This 'ere night's work about winds my pig up, I can tell ye."

Picking Ginger up, and holding him in his arms, the keeper stood in silence. Presently a slight movement took place in the body of the terrier, and with a low whimper and one long-drawn breath he opened his eyes, and then licked the face of his master.

"Jim! hoora! houra! Ginger's alive: oh, my precious Ginger! oh, ain't you tore about! Give us Nipper, an' shove that cusnation warmint in the sack, an' let's git back fur to doctor these 'ere poor things. We'll git 'em round, if 'tis to be done.—Look 'ere, Jim, did ye ever? they ain't hurt much; they're tryin' their werry hardest ter get out o' my hands ter hev another go at him! I don't think as there's sich another pair o' tarriers as these 'ere two, no, not nowheres: there can't be! Ye've got that murderin' warmint?"

"Yes, he's in the sack."

"Then look sharp! we'll cut out o' this; come on! an' next time as master wants a badger fur one o' his friends, somebody else's tarriers 'll hev to drive un. The fust one as we got out was that old warmint's missus an' her cubs. That was a diggin' job, as we wunt forgit in a hurry; 'twas desprit work. But this 'ere bit o' business sets that aside clean. Jim! what are ye sniggerin' about? what's in the wind now, ticklin' yer fancy that way?"

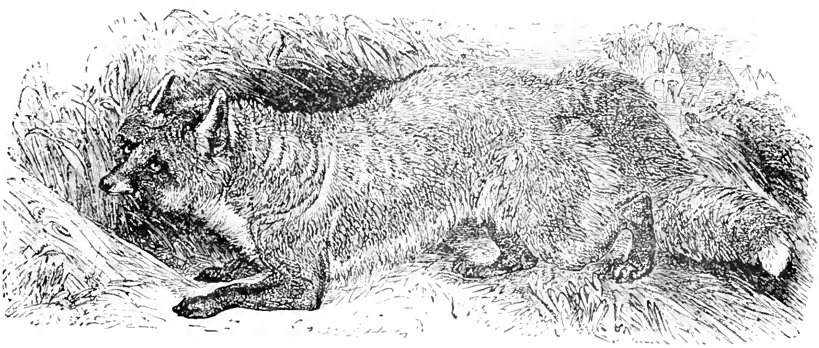
"Oh, nuthin' perticlker. Is Ginger an' Nipper quiet?"

"No, they ain't; I thinks as they'd like ter fall foul o' that 'ere sack."

"Well, I dessay they wud; fur this 'ere warmint has cum round agin', an' is tearin an' scratchin' like mad. It do take a lot to wind a badger's cloc up, that it do!"

"Jim, when we've sin to the dogs, you come up an' hev a pint o' the best cider."

The Fox.—I feel it almost presumptuous on my part to say anything about that wonderful animal, the fox—so much has been written and said about him, both by sportsmen and some of the greatest of our literary geniuses. My account of him will be



English Fox.

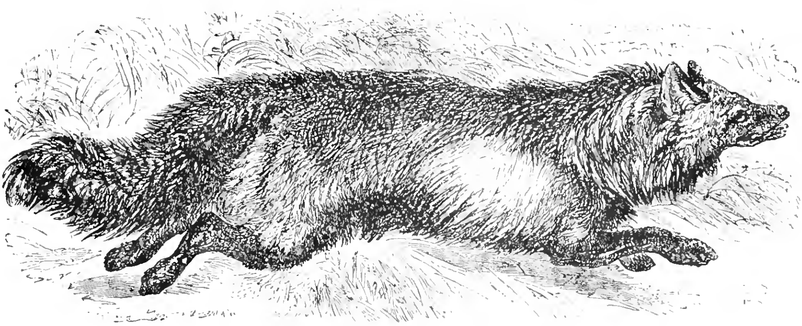
brief; not having the fox-hunter's feeling of veneration for him, nor the hatred natural to the poultry-keeper, my views will at any rate not be one-sided. Nor have I ever had the least wish to possess Master Reynard embalmed as a mummy, or to see the wily gentleman in a glass case, lean and hungry-looking, with squinting cunning in his eye. He is known to me as a clean, swift, strong, and handsome creature, full of courage. He is also universally credited with a very large amount of intellectual power, although it is always said to be employed exclusively for his own benefit. To call an individual of the human family an old fox is certainly not a compliment, for it implies that he is crafty and selfish.

His usual length is four feet, but he varies in size according to food and locality. In the Highlands of Scotland he is *almost* like a wolf in size and strength; and he is not regarded in the same light as in England, for he is shot down without the least compunction there. The proper place to see all wild animals to advantage is in their own home. May I be allowed to say that, in this respect, they are unlike many individuals of the human species?

It is just after four o'clock on a soft May morning, and the sun lights up the tops of the trees, bringing the tender foliage out in sparkling relief against the hill-sides. At the foot of the one nearest us Reynard and his vixen partner have their home. Numbers of fine beeches grow here; the chalky soil is well suited to them. A large one has been blown down at some time, but it has been sawn from the roots long ago. For a long distance the soil was loosened in its fall, and Reynard has taken advantage of this to form an earth for himself and family among the loosened chalk, stones, and old tangled roots. The surface round about is covered with the finest and greenest turf. Many hawthorn bushes are there, giving out their delightful fragrance to perfection, for the morning is warm. On the end of a long beech bough, which reaches far out over the earth, a cuckoo sits and flirts his tail about, shouting, "Cuckoo! cuckoo!" The entrance to the earth and a small space about it is bare, for the little foxes are playful animals, and are at high jinks often, capering about. At present they are, comparatively speaking, quiet, for all their bellies are full. Father Reynard is sitting in the bright warm sunlight, winking in a most knowing manner, while two of his cubs play with his bushy tail to their hearts' content, tossing it from one side to the other in a most comical fashion. Mother vixen has a rabbit in her mouth, which she tosses up and catches, and then lets drop for one of the young ones to nibble at its ears, while the darling of the family torments a poor frog that has found his way there. The whole lot look as though they had a touch of dropsy, their bellies stick out so. The feathers and feet of pheasants strew the ground, and other remnants, for Reynard's motto is: "Other creatures' young ones can cry for food if they let 'em; but mine don't, if I know it."

At some distance the alarm note of a blackbird sounds. Reynard opens his eyes, pricks his ears, and the cubs leave off playing with his tail. The next moment a jay squeaks out, and comes flying overhead. That is enough; he is up on his feet, ears erected, eyes gleaming, and his brush held almost in a line with his back, his fore feet well to the front, the hind ones on the spring. Squeak! squeak! and another jay flits past. With a rush the cubs dash to earth, followed more leisurely by their worthy parents. The cause of their stampede is soon explained, for up the side of the wooded slope a man is seen coming; it is the keeper on his early round.

Reynard is very accommodating as to his food; nothing nice comes amiss to him: game of all kinds, furred and feathered; fish, when he can get the run of them in spawning time, when they are on the sides of the shallows; field-mice, and his especial dainty, a well-fed barn rat. There is no lack of these in the harvest time, and up to the commencement of the winter months. Then they troop back to their old quarters for the cold season. He has a taste for poultry; ducks he values most highly. Perhaps no one but a miller would expect to find a fox in a swamp; but he knows his tricks and likings, and, though he curses him most heartily, yet lets him go free, for is he not St. Reynard? The miller's landlord hunts him in the orthodox manner.



American Fox.

On the tussocks, covered with flag and rush spread all over the swamp, the fox makes a most comfortable retreat. Getting into the middle of one, he twists himself round and round, dog fashion, and there he lies on a nice bed, soft and dry, completely hidden from view, remaining there until the miller informs his landlord's keeper that a fox is there; then the huntsman comes round—and the sooner he does this the better, or there will not be a duck left on the pond.

Reynard can hear them nozzling and softly quacking at the edge of his hiding-place; with cat-like steps he creeps closer, looking through the flags. When he finds that he is near enough for a jump, there is a splash, and one low quack and the drake is in his mouth. In pictures you may see him represented with his quarry slung over his back. This is not correct; he carries what he has caught in front of him, like a retriever. More than once, when in search of wading birds, have I come on the retreats of the fox and the otter very near to each other. For cool impudence, match him if you can. I have known a dog fox, when the vixen had the care of a family, enter the yard of the keeper's house, take one of his game hens from under his living-room windows, march off with it across the road and to his home, give it to his family, and then come back for another. A pointer was in the yard at the time, chained to his kennel. Driven off at his second visit, he coolly recrossed the road to the turf, squatted on his haunches there, and looked over at the yard, and the game hens used for hatching out the pheasants' eggs. It was too much for the keeper to put up with. Slipping a cartridge into his gun, he swung it up to his shoulder and let drive at the fox, saying, "There's notice to quit, you thund'rin' sweep!" Then did Master Reynard play some extraordinary antics. First he jumped off the ground several times in the most lively manner, then he cuffed his ears vigorously with his fore feet, gave a bit of a yelp, and bolted at top speed. His skin is thick, and what would knock other things over would not cripple him.

Arctic Fox.

When the hunters and the hounds chevy him across the fields honest farmer Giles complains most bitterly. "Dash my old gaiters, if I doan't wish as every warmint of a fox as ever run was cold and stiff; that I do; an' 'tis a pity as some folks ain't got better work for their hosses than ridin' over other people's craps an' breakin' fences an' gates. 'Tis wonderful what a likin' most of 'em have fur blunderin' thru a fence an' knockin' the padlock off a gate. Why doan't they jump over 'em? ef their hearts was as big as their hosses hap they wud. That there field of turmits will be punched inter sheep feed, they wunt want to go inter no cuttin' machine. Cuss all fox-huntin'! I sez; 'tis ruin for farmers!"

It was wonderful how quickly farmer Giles was brought to modify these strong opinions on fox-hunting by the appearance of a two-gallon bottle labeled Old Irish, "with the Hunt's compliments." He uncorked the bottle, smelt and tasted it more than once, with and without sugar, ejaculating between each sip, "Massy, oh alive!" Then he walked to those fields again over which they had ridden. Could it have been the softening influence of the Old Irish, or had he been making mountains out of molehills? for when he got back he told his "missus," with a beaming smile of benevolence on his face, that, "raly, considerin' the lot o' gentlemen as 'ad rid over the craps, the little harm as he cum across waunt wuth speekin' on."—*Cornhill Magazine.*

RACE INFLUENCE AND DISEASE.

By G. BERNARD HOFFMEISTER, M. A., M. D.

IT has been my lot to deal professionally for some years with people of divers colors and races, nations and languages in many different parts of the world, and in varied and constantly changing climates. I have thus had exceptional opportunities and sufficient leisure to ponder over racial variations as they present themselves to the medical eye.

Perhaps the most interesting races with whom I have been thrown into contact are the African, and I will consider them first. I have more especially had to do with the natives of East Africa, who are Mohammedans of a somewhat lax and unorthodox type, and yet, owing to their implicit acceptance of Mohammed's fatalistic doctrines, their submission to *kismet* is so complete as distinctly to influence the course of their illnesses.

Indirectly it does so in the following way: When a Sidi-boy incurs, for instance, a wound on his leg, he thinks that if Allah wills that this should get well its healing is certain, but, if the divine wish is otherwise, no human skill or care can do one iota of good; on this account details of simple dressing and protection are quite neglected by this poor fellow, or as much so as the surgeon will allow. If under discipline, he is willing to have his name on the sick list for the privileges which belong to it; but in his heart he despises surgical treatment. Clearly, then, the prognosis with such a case is much worse than it would be in other subjects.

The same argument applies with much greater force to medical cases, on account of the childlike ignorance which exists among such people as to what disease actually means.

This extreme and apathetic dependence on fate forms the greatest difficulty with which the physician has to contend. It speaks well for the blind religious faith of these races, and puts to shame many professing Christians on their sick-beds; but it costs many lives, and entails much extra work on medical attendants, who have perhaps to administer remedies with their own hands, and that often under great difficulties and at much personal sacrifice.

Another more direct point, and one which adds to the gravity of the prognosis, is that these men are not at all anxious to recover; their idea of the value of life is very low, their present existence is usually a hard one, while their religion promises them better times in their heaven, so that if Allah wills to take them they are in luck, and by no means to be pitied.

Now, we all know what it is in the crisis of a severe illness for a patient to have pluck, and a sufficient supply of doggedness to be capable of making a continued effort; to make up his mind in his saner moments not to yield to the sinking feelings that *will* come over him, to fight against his illness as against an attacking enemy, to feel that he is *determined* to pull through, if only to please his friends, to spite his rivals, to foil his foes, or to accomplish some non-completed task. I remember to have had somewhat similar ideas in my own maladies, and I feel sure they were of much assistance to my recovery.

Such impulses as these from the organs of thought and will must of necessity have a distinct effect upon the rest of the nervous system, and thus over the heart and other organs, if only through the emotions, and that a beneficial and stimulating effect; these impulses may therefore make all the difference in tiding over a crisis, and during early convalescence. But of course the influence of the mental state upon disease is unquestioned. The absence in these races of this important factor, and the presence of the stagnating fatalism above mentioned, are, I feel sure, the causes of many a death.

One of my first cases, and it taught me a great lesson, was that of a stalwart East African who complained of feeling ill; on examination nothing could be found amiss but slight febrile symptoms and a small patch of pleuritic friction. To my surprise, the poor negro began by saying he was going to die; he went to his bunk, and next day I found him much the same, except that the heart's action was rather enfeebled, though no physical signs of cardiac disease could be detected. He was, however, utterly uninterested in his condition, and only took food under compulsion. In the evening he suddenly expired, more as it seemed—for I was unfortunately unable to make a *post-mortem* investigation—from what I might call *inertia* than from his actual disease. Later experience told me that had I bullied the man, and given him brandy with my own hand, and stirred him out of his apathy, I might have saved his life. But it was often noticed among us that if, on becoming ill, these men predict that they are sick unto death, they will, if left to themselves, simply go and lie down and quietly die, refusing all assistance.

Confirmation of this view is found in the following words of Hume Nisbet, when speaking of similar races:

"When hope ceases to glow in their breasts, or a superstitious omen tells them that they are to die—it may be the word of the magician, or the bone pointed at them, as among the Queenslanders, or the lizard running over them, as with the Maori, or the utter weariness of life taking possession, as with the Sidi-boys—they can lie down and give up life as easily and methodically as they fall asleep.

"This will-power is utterly beyond the comprehension of us Westerns, nor can doctors give the complaint a name; sailors say they die out of 'pure cussedness.' A Maori will count up the days he has to live, inform his friends of the fact, and die up to time; he calmly lies down and dies without an effort."

So much as regards the course of diseases; now as to treatment. The most successful means of treating such cases lies in the use of alcohol, and so unaccustomed are most of these people to its action that very small doses are required to produce a good effect. It acts partly by a kind of intoxicating influence, putting a little energy, or even "devilment," into them. If administered with cautious judgment, this support may be kept up until convalescence is fairly established, when with returning strength they realize that destiny means them to survive; here the ordinary good effects of stimulant treatment are much enhanced by the previous abstinence.

It is well known how very excitable are these woolly-haired, thick-lipped, flat-nosed races, the excitement representing the opposite mental condition to the extreme languid depression of which I have already spoken. For instance, at the great *Mohurram* festival at Bombay, which I once witnessed, I noticed that all the noise and mad dancing and boisterous fanaticism of the night processions were manifested, not by the natives of India, who were in a large majority, but by the negroes, their religious fervor and the frenzy born of *bhang* conspiring to excite them. It is this sensitiveness to rapid mental change that gives alcohol such potent virtues with them in sickness.

The natives of our Eastern empire, always excepting the fine Sikh races, and those living near the northern frontier, than whom I have never seen finer or braver specimens of mankind, are people of poor stamina, and are easily prostrated. Timid and feeble, they dread the pain of illness, and dislike the thought of death mostly on account of the ordeal of the dying process. They are therefore ready, nay, over-anxious for medical treatment, and are fond of both liniments and physic. But in spite of this they fare worse than the Europeans in all ordinary diseases; symptoms are more severe if less sthenic, prognosis is graver. Some explanation may be found in their habitually poor diet, which leaves little balance to the credit account in the nutrition of the tissues, and consequently small resisting power to disease, but more, I think, belongs to a want of "real grit" among them, a characteristic racial failing.

For example, a catarrhal condition of the alimentary canal will pull such a patient down with alarming rapidity, out of all proportion to the other symptoms, and indeed often to a fatal ending. Stimulants in such cases are, of course, of great use, but not to the same extent with our Aryan brother as with the Africans. With small abrasions and ulcers healthy granulations are the exception, lymphatic abscesses are a frequent result, and belong to a low phlegmonous type, pyæmia often supervening. Perforating ulcers of the feet and gangrene about the toes bear evidence to a poorness of local nutrition, and a low vital tone of some of the tissues, also shown by the fact that necrosis of bone is a much more frequent sequela to blows than with hardier nations.

Another point that I have noticed is that minor ailments, such as coryza, etc., take a much more severe course than that with which we are acquainted.

Both the Indians and Africans are much less subject to ill effects from changes of temperature than are Europeans. This is perhaps to be expected in tropical climates, and may be due to the excellent way in which their sweat-glands respond to an extra call upon them, consequent probably on their scantier clothing and less constant interference with the natural skin-functions. Also, in spite of their thin cotton garments, sudden and temporary exposure to a winter climate produces a very small percentage of sickness among them, though those who do suffer become really ill. True, they grow torpid and incapable of much work; but, if Europeans were exposed as much as I have seen these darker races, I feel sure a very much larger proportion of them would soon be on the sick-list.

Chinese and Japanese make much better patients. They have faith, want to recover, and endeavor to do so. They are fairly tractable and obedient, their average constitution is more robust, and they are not destitute of moral courage; consequently treatment yields in their case better results.

Among European nations I have been much struck with the difference in the course of sickness between the Teutonic and the French people. For instance, I have witnessed the effects of extreme heat in the Red Sea, through which I passed seven times in a single year. The phlegmatic German, from sheer stolidity, stays exposed to the sun until he feels queer, then comes below and takes a large draught of beer, which, of course, makes him much worse. His condition soon becomes one of typhoid delirium bordering on stupor, but he is easily treated, and soon recovers. Now, look upon the other picture. The fussy Frenchman, from rank obstinacy, exposes himself to a high temperature, and on feeling ill becomes at once fearfully alarmed, wants to try every remedy at once and nothing long, blames every one but himself, grows noisily delirious, and finally works himself into a state of extreme exhaustion which materially adds to the gravity of his case.

The above personal observations have led me to search out evidence to support my views on the subject, and I now append a very brief account of what I have found in reference to particular diseases, specific and otherwise.

INFLUENZA.—Isolation for long periods from other races, as in the case of insular populations, causes influenza and similar epidemics to run a more severe and dangerous course; witness the cases of St. Kilda and the Society Islands. An epidemic takes place when the infecting visitors are afflicted with apparently only the slightest of colds, while less recent arrivals, if attacked, suffer far more lightly than do the older inhabitants, though more so than the visitors themselves. During my stay at Ascension Island I was told by a resident official that a cold introduced from a passing vessel runs through the island as a severe epidemic, necessitating rest in bed and active treatment for several days. This effect is still more virulent, leading even to fatal results, in the island of Tristan d'Acunha, where the isolation is much more complete, and the people are of British origin.

Now, sea-water is by no means the only method of isolation, and in earlier ages, situation, feuds, and scanty means of locomotion were efficient causes. When a tendency to a particular complaint becomes increased by long periods of isolation, so that heredity is able to accentuate any special proneness, one possible explanation of the origin of pathological racial idiosyncrasies is afforded.

DENGUE.—African races incur this disease much less frequently than do others, and with them it takes a very mild form, being highly amenable to expectant treatment and simple care. On the other hand, the natives of India suffer in greater numbers and much more severely than do Europeans even, and show a much higher death-rate from it. Now, there are many African immigrants in India, and *vice versa*, yet this racial law still holds good among them, even after some generations.

SMALL-POX.—Both the negro and the Arab tribes in the Nile regions of Africa, and also the Aryan races of central Asia, have from time immemorial suffered cruelly from variola. Vaccination has lessened the value of comparative statistics on this point, but the mortality from the disease has been and is positively awful, complete depopulation sometimes resulting in particular valleys or islands.

MEASLES as an epidemic has caused terrible devastation among insular races, especially in warm climates, assuming a far more virulent type than that known to Europe, among people less capable of resisting a panic-creating disease.

MALARIA.—Here occur the best instances of acclimatization of races. Ethiopians are affected less frequently than are other peoples, and with diminished severity. Blonde and blue-eyed Europeans, as with gonorrhœa and some other complaints, furnish the worst victims. As regards its treatment, quinine has far less efficacy with them than with us, and arsenic is more of a specific remedy to them, though this depends on the actual variety of the fever. With the negro, after-effects upon the constitution are quite exceptional.

Yellow Fever.—Special liability and increased mortality belong to the light-haired Europeans, and acclimatization is by no means absolute; yet pure-blooded negroes possess congenital immunity, which is certainly absent from Redskins, or Hindoo coolies, though the Chinese are almost exempt.

Cholera.—The African races incur the greatest danger from this dread disease, dying off without an effort at resistance and with the greatest rapidity, giving little opportunity for treatment. Europeans and Hindoos, however, provided the latter are under fair hygienic conditions as to food, etc., suffer very similarly. After a famine the Indians, deprived of all resisting power, fall ready victims.

Typhoid Fever gives a typical instance of acclimatization of race through heredity, for in tropical regions the disease is often completely limited to strangers. During my visit to Jinjeera, off the Malabar coast, I was informed that the foul water of the large "tank" is certain death to a European through this fever, and yet it forms the ordinary drinking-water supply of the crowded inhabitants. Among such people mild cases, due probably to the same poison exerting a much mitigated action, are, however, not infrequent. In this instance time has apparently produced a modified form of the disease by a general protective process of natural infection, similar in its effects to inoculation, as well as by the all-pervading action of natural selection and accommodation to environment.

Leprosy is well known specially to select tropical races, and to run a more rapid course with them.

Syphilis punishes negroes of the coast of Africa often and very viciously. Phagedæna forms an ordinary complication, as also does bone-disease; and specific treatment has to be pushed with perseverance. On the other hand, the central Africans are remarkably exempt, as are also Icelanders and Greenlanders. In Chinese ports Europeans suffer extremely when compared with the natives, as if the poison, like other living species, had its varieties. Perhaps, too, an inherited natural inoculation becomes a protection to particular races.

Bronchial Catarrh for some reason, it may be carelessness as to clothing and dwelling, inflicts greater punishment on indigenous dark races than on strangers among them, runs a much more trying course, and is more resistant to therapeutic influence.

PNEUMONIA.—Natives of the tropics, and more especially negroes, whether at home or abroad, are peculiarly subject to this acute fever. The death-rate and average of severe cases are among them exceptionally high.

PHTHISIS is also remarkably rapid and frequent with these races when sojourning for many months in cold climates, but less so with the southern Asiatic.—*The Practitioner.*

SCIENTIFIC JOTTINGS IN EGYPT.*

By Dr. H. CARRINGTON BOLTON.

THE following pages record impressions and observations made in the spring of 1889, during a brief sojourn in the Nile Valley, and a more deliberate study of the Sinaitic Peninsula. In discussing one's experience on a journey the weather claims early notice. In February, at the hotel in Cairo, the thermometer ranged from 60° at 8 A. M. to 78° at 3 P. M.; but on the Nile steamer much greater extremes were noted, 54° at midnight (February 19th) to 87° at 2.30 P. M. (February 9th). In the shade the heat was rarely oppressive.

The temperature in the desert in March was favorable to the traveler's comfort, with rare exceptions; the thermometer ranged from about 60° to 80° in twenty-four hours at the sea-level, and from 48° to 75° at the elevation of about five thousand feet.

The highest evening temperature was on March 17th, after the *khamsîn* had blown all day—at 7 P. M., 84°. The lowest temperature observed was on March 20th, in camp about three thousand feet above the sea—at 6.30 A. M., 33°. (In February, 1874, Rohlf noted in the Libyan Desert a minimum temperature of 23°.) In considering the physiological effects of these temperatures one must remember the extreme dryness of the atmosphere in the desert.

My first experience in Egypt was calculated to give the impression that it is a rainy country, for I saw two showers in three days. In passing through the Suez Canal (January 31st), a heavy shower, lasting half an hour, drove the passengers to shelter, and a brilliant rainbow delighted beholders. Two days later, rain again fell at night in Cairo, making the dirty streets more nasty still. Of course this experience was exceptional, as rain is a rarity in Cairo. Authorities give the rainfall at Alexandria as about eight inches per annum, and at Cairo about

* Abstract of a paper read to the New York Academy of Sciences, February 24, 1890, and condensed by the author from the Transactions, vol. ix, p. 110.

1·2 inch, while in Upper Egypt the precipitation of moisture is far less; there are adults who say they have never seen rain.

I noticed, on the other hand, unmistakable signs of recent rains, such as dried mud-puddles, rain-drop prints, etc., at several points, near Cairo, east of Thebes (Wadi Bab-el-Molook), and in the peninsula of Sinai, and I was impressed with the belief that more rain falls in Egypt than is usually supposed. A local shower passing over a sandy, gravelly region, makes but little impress on it; and there is no corps of trained observers, outside of Cairo and Alexandria, to record the phenomenon. On visiting the Khedivial Astronomical Observatory just out of Cairo, I was cordially received by the director, Mr. T. Esmatt, a graduate of the École Polytechnique of Paris, and for three years an assistant in the Naval Observatory at Washington. I take pleasure in mentioning his politeness and courtesy, but I can not omit pointing out a weakness: he took me to the roof of the building to see the meteorological instruments, and I noted that the rain-gauge was quite full of water; this again gave me reason to regard Egypt as a rainy country. (The last shower fell one month previously.)

During my journey in the desert (March 13th to April 8th) rain fell three times in my vicinity: twice the fall was insignificant, lasting only two or three minutes, but on March 19th rain fell abundantly in Wadi Feirân, from 7.15 A. M. to 9.30 A. M. Heavy mists had obscured the peaks bordering this extensive valley nearly all the preceding day; the temperature during this rainfall was 52°, elevation about nineteen hundred feet.

That heavy falls of rain and even of snow occur in December and January in the Sinai region, is reported by many travelers; in the defile of Nakb-el-Hawi (five thousand feet), crossed by pilgrims *en route* for the sacred mountain, the winter rains make veritable torrents; in 1867 the water rose to such a height in the valley adjoining, Wadi Selâf, as to wash away a camp of Bedouins, causing a loss of forty lives and of numerous cattle (Baedeker). Captain Palmer describes also a sudden precipitation so copious as to fill the bottom of Wadi Feirân to the depth of several feet, causing the party to seek high ground. That the Oasis of Feirân was once the site of a village of anchorites and monks sufficiently important to become an episcopal see, is known to students of history; this was in the second to the sixth century A. D. A few cut stones, the capital of one column, and ruined sites, alone remain to indicate the locality.

Powerful winds sweep across the plains and through the valleys of Arabia Petræa, with a violence and continuity that I have not elsewhere experienced. In the spring months the prevailing wind in the desert is from the north and northwest, down the gulf. This wind is a cool one, but it occasionally veers around to the south and becomes oppressively hot. In April and May this south wind, called *khamsîn*, blows unremittingly for days together, scorching the traveler's skin and filling the orifices in his head with a very fine dry dust. *Khamsîn* is from an Arabic word meaning fifty, so called from a mistaken notion that it blows for a period of fifty days before the summer solstice.

In the Nile Valley, north winds prevail during the heated period of eight months, and southern winds during the rest of the year; these being in the opposite direction from the winds in the region of the Red Sea.

I witnessed three characteristic sand-storms at localities far apart and under varied circumstances. On February 15th, when riding a donkey through Thebes Nileward, a powerful west wind arose in the afternoon, blowing before it fine dust from the Libyan Desert. Words fail to describe the discomfort of such a sand-storm; the fine dust seems able to penetrate everything except perhaps an unbroken egg, and it is quite impossible to escape from it; to prevent suffocation, I borrowed from a fellah a coarse yet closely woven blue outer garment and wrapped my head up. Donkeys did not seem to enjoy the phenomenon any better than the Bedouins, and they shrank from its blast as well as the travelers. After crossing to Luxor in a boat, we found the residents in the large hotel much inconvenienced by the penetrating dust, although the building is screened by a handsome garden.

My second experience was in Cairo itself. On March 6th a northwest, and consequently a cool, wind blew dust from the adjoining desert into the city with such power as to obscure the usually brilliant sun during an entire day. Residents of Cairo said that the sand-storm was the severest in twenty-five years, and of an unusual character—being accompanied by a low temperature instead of the scorching *khamsîn*.

I experienced a third sand-storm in the desert of Sinai, on the plain of El Markha; it was accompanied by a scorching south wind, and the drying effects on the skin and the capital orifices produced greater discomfort than the suffocating dust and cutting sand; my party could do nothing but sit in silence on our camels, facing the storm, and the poor animals forgot to snatch at the tufts of scanty shrubs, as is their custom. In the evening the fierce wind very nearly overturned our tents in spite of extra stays, and at dinner every course was seasoned with the all-penetrating dust. The temperature at 7 P. M. was abnormally high, 84°; just twenty-four hours later it fell to 58°, the wind having meanwhile veered around to the north, bringing with it heavy mists.

Before dismissing the subject of climate, I wish to testify to the invigorating, delightful air in the desert; it has a bracing quality that enables one to expend much energy without fatigue. From about 1 to 3 P. M. the glare of the sun is often great, and shade is a comfort; but the constant breeze, sometimes rather too strong, tempers the heat. I suspect, too, that the air is very free from disease-germs.

In the journey from Suez to Sinai by the ordinary caravan route, one crosses undulating plains, limestone and sandstone hills, and eventually reaches bold granitic mountains, rising to the height of eight thousand feet. Each of these regions is furrowed by wadis, or dry water-courses, which present very different aspects in the three divisions named. The first fifty-two miles of the journey, occupying about two days and a half, as camels travel, cover an arid, sterile plain about ten miles wide from the low range of limestone hills on the east, Et Tîh, to the gulf on the west. This plain, like that of El Gâa, to the south, rises gradually from the sea to the foot-hills, and is undulating toward its southern end. It is crossed by broad, shallow wadis, running east and west, which were perfectly dry at the time of my visit; Wadi Werdân, the largest, is depressed but a foot or two below the level of the plain, and is approximately three miles in width at about six miles from the point where it enters the sea.

The most extensive plain on the western side of the peninsula is that of El Gâa, which is about eighty miles long and fifteen wide at its widest point. From the sea-coast to the mountains bordering it on the east it rises nearly one thousand feet, but so gradually as to deceive the eye and appear level. It is crossed by many shallow wadis, and its northern half is separated from the sea by a range of limestone hills (Jebel-el-Araba) reaching a height of sixteen hundred feet. When the plain was covered by the sea, this range was probably an island, or series of islands. The plain is rarely broken by hills, the sharp-pointed Krên Utûd, conspicuous from a distance, being an exception. I crossed the monotonous desolate waste, from the mouth of the beautiful Wadi Es-Sleh to Tor (or Tûr), on the gulf, a distance of about fifteen miles, and noted scarcely a dozen tufts of plants; water is absolutely wanting. North of Tor, however, and east of Jebel-el-Araba, are palm-gardens that extend for several miles in a narrow belt; and these date-bearing trees owe their existence to several saline springs occurring at intervals, some of which were quite warm. On this sterile plain the characteristics of a desert are seen in perfection: the level expanse is not too broad to conceal the lofty mountains on the east, nor to prevent glimpses of the blue sea on the western horizon; the floor is a firm, hard surface, made up of a compact mixture of gravel and coarse sand, so hard indeed that camels make no impress on it with their broad feet. At some places the surface pebbles are of many shades of brown, intermingled with black and white, and these are so closely laid and regularly distributed as to resemble a mosaic pavement, but of course a patternless one. The surface particles are generally coarser than those immediately beneath; they are chiefly limestone, sometimes of coralline limestone, intermingled with flint and other varieties of amorphous quartz. Many of the pebbles show on their surface beautifully regular pittings and furrows carved out by the wind-driven sand. The fine-grained sand has all been lifted high in air by the powerful winds, whirled away, and dropped into depressions or on the lee sides of hills. Hundreds of acres have no surface stones larger than an ostrich-egg; no water whatever is found in this region, much less any signs of vegetable or animal life, rarely even a passing bird.

On this desolate plain, when overtaken by night, one place is as good (or bad) as another for pitching the tents, unless perhaps a small hillock is reached, which may serve as a partial shelter from the gales that sometimes threaten to overturn the canvas.

In the region of extensive plains, the wadis, or dried-up water-courses, being depressed but little, closely resemble them. The floor of the wadi hardly differs from that of the plain, except when a torrent has swept before it large bowlders and deposited them irregularly in its bed. The sorting power of the water, however, is noticeable, as also the well-defined vertical walls, perhaps only a few inches deep, excavated at the point of lowest level. On the margins, too, of the wadis of the plain, and at points protected from the full force of the winter floods, several varieties of green shrubs grow in widely separated tufts. I often remarked mud-cracks, apparently of recent date; but these indications of water probably remain undisturbed in this desolate region for a considerable period, perhaps for several seasons.

In the limestone hills these wadis take the form of cañons, having nearly vertical walls, sometimes hundreds of feet high—as in Wadi Tayyibeh. The regular erosion on their sides produces, often, picturesque effects, as at Ras Abu Zanîmeh.

In the granitic district the wadis form V-shaped valleys, broken by narrower ones entering at right angles, and bounded by bold peaks many thousand feet above the beholder. In the beds of these wadis are scattered specimens of the rocks of the surrounding country; often bowlders of great size testify to the violence of the torrents during the winter months, especially in Wadi Feirân.

The absolute dependence of the population of Egypt upon the Nile is a familiar fact, discussed from the time of Herodotus to the present day. The proposed reopening of Lake Mœris in the Fayoum district, for irrigating the Delta, has been fully explained to the Academy by one of our members, Mr. F. Cope Whitehouse, its enthusiastic advocate.

The conditions of occurrence of water in the desert are perhaps less familiar. Not only is water scarce, but when obtained a large proportion of it is practically unpotable, being saturated with saline matter to such an extent that the soil in the vicinity is white with efflorescent salts of soda, magnesia, and lime. The "bitter waters" of Marah are not exceptional. The longest journey that I made without meeting good drinking-water was on the return from Tor to Suez, a distance of about one hundred and fifty miles, occupying six and a half days. On this route we passed a well in Wadi Gharundel where camels and Bedouins slaked their thirst, and our water-barrel was replenished with water for washing; but had we not been supplied with sweet water from the Nile, brought down to Tor on a boat from Suez, we should have fared badly in this respect. At the time of my visit all wells were admittedly very low, and in some places entirely dried up; so I saw the region in its most arid aspect.

Good water, flowing from springs and running short distances—say a quarter of a mile before sinking into the thirsty soil—is found in Wadi Feirân and in Wadi Tarfa. In the former place, many date-palms and even barley-fields make a charming oasis; at the latter, palms, canes, and tamarisks line the babbling brook, as it may truly be named, but the oasis is not extensive. North of Tor, on the gulf, are flowing springs of warm and saline water, not very palatable, but admirably adapted to the culture of date-palms, of which there are many thousands. The best drinking-water in the region that I have visited is on the flanks of Sinai. There are four wells within the monastery walls, one without, and others in the Leja Valley and vicinity.

In Wadi Es-Sleh, the romantic gorge southwest from Sinai, I discovered a cold and sweet sulphur spring, agreeable to the palate. It issues in the center of the wadi, at a point two hours' journey east of its mouth, and flows a short distance, depositing characteristic bluish sulphur on its borders. It was this latter that first attracted my attention. This spring is not mentioned in Baedeker's guide-book, generally so accurate.

The total absence of ponds and lakes is a marked feature in the physical geography of the peninsula of Sinai. Rain does at times fall in abundance, but it rushes precipitately down the wadis into the seas which bound it on two sides. Yet there is evidence of the existence of lakes at some earlier period. In Wadi Feirân, banks of earth sixty to one hundred feet high rest on the mountain-sides, especially in the angles of the valley, showing clearly the former existence of a lake, the barrier of which was probably near Hererât. I noticed also, at the point where the Wadi Es-Sleh enters the plain of El Gâa, unmistakable signs of an ancient lake. The wadi emerges suddenly from the mountain-range, and a circular depression from thirty to fifty feet deep, with a perfectly level sandy bottom and bounded by nearly vertical gravel cliffs, now marks the bed of a small lake.

The uninhabitability of the peninsula is due to its sterility rather than to its climate. Its sterility is due, I imagine, more to the unequal annual distribution of the water than to its absence, and, should the population warrant it, storage-dams, easily constructed in the narrow granite-walled wadis, would to a great degree remedy this defect. Perhaps at some future day, when a crowded world thrusts its surplus population into regions now hardly regarded as habitable, Arabia Petræa will bloom like a garden. Granite and limestone furnish valuable soil-ingredients, and the climate is not unfavorable to semi-tropical cultivation.

The flora and fauna of the desert have been often described, yet I imagine that much remains to be studied; the variety, beauty, and fragrance of the shrubs and flowers which the traveler meets in the most forbidding and unexpected spots were to my unprepared mind a remarkable feature. In March I gathered dandelions and daisies at Wadi Useit, also "butter and eggs"; in Wadi Tayyibeh, near saline water, spearmint; and in Wadi Feirân, on the hillsides, sorrel.

The oases with their date-palms, *tarfa* (or tamarisk) yielding manna, *seyâl* (or acacia) yielding gum arabic, *gharkad* shrubs, and thickets of tall reeds, are veritable islands of fertility in an ocean of desolation. At the monastery, cypresses, oranges, peaches, and vines are cultivated, although five thousand feet above the sea-level.

Naturalists enumerate a number of large animals that live in the oases of the desert, among them the gazelle, ibex, jackal, and fox. I met with the head of a gazelle and numerous horns of ibexes, and in Wadi Es-Sleh a Bedouin suddenly appeared with two little half-tamed ibexes about fourteen days old; my traveling companion bought them, but they were unable to withstand the novelty of camel-riding, and, though kindly cared for, died within a few days. Their skins were preserved. I noted on the journey a large field-mouse, a small light-yellow snake two and a half feet long, and a peculiar kind of lizard (?). At Assouan I killed an intensely energetic scorpion, and at many places noted chameleons basking in the sun. Of the numerous and curious fish in the Red Sea, I can only say that some of them proved to be excellent food.

Insects were rarely seen in the desert, and only in the neighborhood of water, or in the oases. I observed red and black ants, one large caterpillar, very few flies, many black beetles leaving behind them well-defined tracks as they crawled over the fine-grained sand, a few moths, a bee, a grasshopper, many spiders, a lady-bug (so called), gnats near the sea-coast, and my traveling companion noted fleas. Mosquitoes, so abundant in Cairo, were not seen nor heard. Twice large birds sailed high above our heads. This is the total of animal life met with in my four weeks' journey, excepting camels, goats, one lamb (which we ate), one donkey (at Tor), a dozen cats (at the monastery), several Bedouins, two Russian ladies, two German philologists, two Irish theologians, three enterprising Americans, and twenty-nine lazy monks.

WHALE-CATCHING AT POINT BARROW.

By JOHN MURDOCH.

ALL through the latter part of the winter the seal-hunters, who are out every day tending their nets, along the shore from Cape Smyth to Point Barrow, have been watching and studying the ice. Running along nearly parallel to the shore and about a thousand yards off, is a bar on which the water is not more than two or three fathoms deep. On this the heavy pack-ice, coming in with the autumn gales, usually grounds, piling itself up into a wall of rugged masses of ice, while inshore the sea freezes over smooth and level. Outside of this is the rough pack, broken masses of ice piled up in irregular heaps like the craggy fragments on a frost-riven mountain-top, but interspersed with undulating fields of ice, many seasons old, and thick enough to resist the pressure when the ice-fields come together before the winds and currents. Occasionally, too, the grounding of heavy masses of ice—there are no true icebergs in this part of the Arctic Ocean—affords sheltered spaces where fields of "new ice" can form undisturbed by the movements of the pack.

Through January, February, and March these ice-fields remain motionless, or are only crushed closer together and pressed harder upon the land by the prevailing westerly gales; but in April the pack gradually begins to loosen, and when the long-wished-for east wind blows, cracks open six or seven miles from the shore, extending often for miles, parallel to the land. These cracks or "leads," as they are called, seldom remain the same for many days, but open and close as the wind changes, now spreading clear of all obstructions for hundreds of yards or even for a mile in width, now filled with loose ice, floating with the current.

It is in these leads of open water that the whales work their way to their unknown breeding grounds in the northeast, passing by Point Barrow chiefly during the months of May and June, and it is during this season of migration that they are hunted by the Eskimos.

The chase of the whale is of great importance to these people. The capture of one of these monsters means meat in abundance; blubber for the lamps, and for trade with the Eskimos whom they meet in the summer; whalebone to purchase ammunition; tools and luxuries from the ships; and the choicest morsel that an Eskimo knows, the "black-skin" or epidermis of the whale. Consequently, the successful whaleman is the best man in the village, and soon grows rich and influential.

But to return to the seal-hunters and their observations of the ice. From long experience, the Eskimos are able to judge pretty accurately where the "leads" will first open in the spring, and, when they have concluded where the boats will be launched, they set to work to select the best path for dragging out the boats through the rough ice-field. They soon make a regular beaten trail, winding in and out among the hummocks, taking advantage of all the smooth fields of ice that they can, and, from time to time as they pass back and forth from their seal-nets, they chip off projecting corners of ice with their ice-picks, and with the same implement widen out the narrow defiles in the road, and smooth off the roughest places. Men sometimes go out on purpose to work for a few hours on the road, using ice-picks or "whale-spades" (something like a heavy, broad chisel, mounted on a long pole, used for cutting the blubber off a whale), which they have obtained from the white men. It is a pretty rough path, however, at the best.

By the middle of April all the hunters have returned from the winter deer-hunt, and the business of getting ready for whaling is taken seriously in hand. The frames of the great skin boats must be taken down from the scaffolds where they have rested all winter, and carefully overhauled and repaired, while every article of wood that will be used in whaling, from the timbers of the boat to the shafts of the spears and harpoons, must be scraped perfectly clean, in honor of the noble quarry. Gear must be looked to, and the skin covers for the boats repaired and soaked in the sea, through holes in the ice cut close to the shore, till they are soft enough to stretch over the framework.

Meanwhile, a careful watch is kept from the village cliff for the dark cloud to seaward which indicates open water; and if the much-talked-of east wind does not speedily begin to blow, the most skillful of the wizards or medicine-men get out on the bluff, and with magic songs and beating of drums do their best to make it come.

It is not every man in the village who owns an *umiak* that fits it out for whaling, as it requires a good deal of property to procure the necessary outfit. About eight or ten boats from each village make up the usual fleet. The crews—eight or ten men to a boat—are made up during the winter.

The owner of the boat—who is always the captain and steersman—sometimes hires his crew outright, paying them with tobacco or cartridges or other goods, and sometimes allows them a share in the profits, but, I believe, always feeds them while the boat is "in commission." When enough men for a full crew can not be secured, women and even half-grown lads take their places in the boat. One man is selected for harpooner and posted in the bow, and usually another, amidships, has charge of a whaleman's bomb-gun, for firing an explosive lance into the whale, for most of the rich Eskimo whalemen now own these guns.

Now, as to the instruments used for the capture of the whale. Instead of harpooning the whale, or "fastening" to him, as the white whalemen say, and keeping the end of the line fast in the boat, which the whale is made to drag about till the crew can manage to haul up and lance him to death, there is but a short line attached to each harpoon, to the end of which are fastened two floats made of whole seal-skins, inflated, which are thrown overboard as soon as the harpoon is fixed in the whale. Each boat carries four or five harpoons, and several boats crowd round and endeavor to attach these floats to the whale every time he comes to the surface, until he can dive no longer, and lies upon the water ready for the death-stroke. Some of the harpoons are regular whalemen's "irons," but they still also use their own ingenious harpoons, in which the head, made of bone or walrus ivory, with a point of stone or metal set into it, is alone fastened to the line, and is contrived so as to "unship" from the shaft as soon as it is thrust into the whale, and to turn at right angles to the line, like a toggle, under the skin. To kill the whale after he is harpooned, they used in old times long lances, with beautifully flaked flint heads, as broad as one's hand; but now they all have regular steel whale lances, and, as I have said before, most of them own bomb-guns.

Some of the boats are carried out over the ice to the place where they are to be launched before the "lead" opens, and, as soon as open water is reported by the scouts, all start. There is a great deal of ceremony and superstition connected with the whale-fishery. The captain and harpooner of each boat wear special trappings, and streak their faces with black-lead, as, indeed, is often done on festive occasions. Long before the time for whaling, all those who intend to command whaling boats during the coming season assemble, with all their gear, in the public room and hold a solemn ceremony, with drumming and singing, to insure good luck. Charms and amulets of many kinds are carried in the boats. They believe that the whales are supernaturally sensitive. If the women should sew while the boats are out, or the men hammer on wood, the whales, they say, would leave the region in disgust.

Let us see, now, how the boats are carried out over the path I have described. The boat is firmly lashed on a flat sledge, to which a team of dogs is attached, while the men and women hold on to the sides of the boat, pushing and guiding. Hearing, one day in May, 1882, that one of the Cape Smyth boats was starting for the edge of the ice, two of us set out over the trail, and overtook the party about two miles from the shore, where they were resting, having sent the dogs ahead in charge of two women, with another sledge loaded with all sorts of gear—rifles, spears, and so on. The party consisted of five men and two women. The captain of the boat and the harpooner wore on their heads fillets of the light-colored skin of the mountain sheep, from which dangled on each side a little image of a whale, rudely flaked from rock-crystal or jasper. The captain's head-dress was fringed with the incisor teeth of the mountain sheep, and the harpooner had another stone whale on his breast. One of the women was decorated with a stripe of black-lead diagonally across her face. In the boat, for charms, were two wolves' skulls, the dried skin of a raven, a seal's vertebra, and several bunches of eagle's feathers. They say the skin of the golden eagle—"the great bird"—or a bunch of hairs from the tip of the tail of a red fox, bring great luck. In the boat were also five or six inflated seal-skins, which, when we came up, they were using for seats on the ice.

One of the women soon came back with the dogs, the seal-skin floats were tossed into the boat, the dogs hitched up, and we started ahead, the woman leading the dogs, and the men shoving alongside. When we came up with the first sledge, the dogs were unhitched from the boat and sent ahead with a load of gear for another stage, and so on. On smooth ice the boat travels easily and rapidly; but where it is broken it is hard shoving and rough scrambling for the men, while occasional stops have to be made to chisel out projecting pieces of ice and widen narrow places in the path. Then the dogs get tangled up from time to time, and have to be kicked apart, so that their progress on the whole is slow. When they reach the open water the boat is launched and the gear put on board, and the sledges drawn up out of the way. Everything is put in readiness for chasing the whales, and the boats begin patrolling the open water. The harpoon, with the floats attached, rests in a crotch of ivory lashed to the bow of the boat, and everybody is on the alert. Sails and oars are never used in the boat when whaling, but the boat is propelled by paddles alone.

Thus they spend the months of May and June, eating and sleeping when they can, for the daylight now lasts through the twenty-four hours, occasionally hauling the boat up to the edge of the ice for a rest. Somebody, however, is always on the watch for whales or seals or ducks, which last now and then at this season pass by in thousands on their way to the north.

When the "leads" close, the boats are hauled up safely on the ice, and all hands come home till an east wind and "water sky" warn them of a fresh chance for whaling.

Let us suppose that there is good open water, and that a couple of boats are hauled up on the edge of the land floe, their crews resting and gossiping, perhaps waiting for the return of the women who have been sent home to the village for food. Suddenly a faint puffing sigh is heard, and a little puff of vapor is seen over toward the edge of the ice. It is a whale "blowing." The men all spring to their feet and quickly run the boats off into the water, and, scrambling on board, grasp their paddles and are off in the direction of the "blow." If they are lucky enough to reach the whale before he escapes, the harpooner, standing up, thrusts the heavy harpoon into him with both hands, and quickly recovers the pole, to be used again. The nearest boat rushes in; other boats, seeing what is going on, come up and join in the attack until the whale is captured. Sometimes, indeed, an opportunity occurs for a successful shot with the bomb-gun as soon as the whale is struck, and the contest is ended at once. But the attack is not always so successful. Sometimes the whale escapes into the loose ice before the boats can reach him; sometimes the harpooner is clumsy, or the harpoon does not hold. Sometimes, too, the whale escapes before enough floats can be attached to him to hamper him, and carries off the harpoons, floats and all. Even if the whale is killed, he sometimes sinks before he can be towed to the edge of the ice, where the "cutting in" is to be done.

When the "lead" of open water is narrow, the natives who own bomb-guns patrol the edge of the ice, watching an opportunity to shoot the whales as they pass. It was when engaged in this kind of hunting that a young acquaintance of ours at Cape Smyth came near losing his life. A man near him, handling his bomb-gun carelessly—the Eskimos are all frightfully reckless with fire-arms—discharged it by accident, sending the bomb into the ice under his feet, where it exploded, shaking him up like a small earthquake.

When the whale is killed, it is towed, as I have said, to the edge of the solid floe, and the work of cutting him up begins. By long-established custom, universal among the Eskimos, the skin, blubber, and flesh of a whale belong to the whole community, no matter who killed it; but, at Point Barrow, the whalebone must be equally divided among all the boats that were in sight when the whale was killed.

They have none of the appliances used by civilized whalemen for easily and rapidly stripping off all the blubber, but hack away at everything in reach, getting off all they can before the carcass sinks. The news soon reaches the villages that a whale has been killed, and there are very few households that do not send a representative to the scene of action as speedily as they can, with sledges and dogs to bring away their share of the spoils. As may be supposed, there is a lively scramble round the carcass. Some on the ice, some crowding the boats, they cluster round the whale like flies round a honey-pot. Leaning over the edge of the boats, careless of the water, they hack and cut and slash with whale-spades and knives, each trying to get the most he can. So far as I have ever heard, this is a perfectly good-natured scramble, and no one ever thinks of stealing from another's pile on the ice. The blubber, meat, "blackskin," and whalebone are soon carried home to the village. The blubber is not tried out, but is packed away in bags made of whole seal-skins, and, with the meat, is stowed away in little underground chambers, of which there are many in the villages.

The "blackskin" is eaten fresh, and is seldom if ever cooked. This curious dainty is the epidermis or cuticle of the whale. It is about an inch thick, and looks, for all the world, like black India rubber; it is not so tough, however. Civilized whalemen are nearly as fond of it as the Eskimos, but are not in the habit of eating it raw. When nicely fried in the fresh, sweet oil of the "try-pots," when they are "boiling out" the blubber of a whale, for instance, it is very palatable, tasting much like fried pigs' feet. It is also good boiled and "soused" with vinegar and spices. The Eskimos are fond, too, of the tough white gum round the roots of the whalebone.

The jawbones of the whale are cut out and preserved. From these and from the ribs are sawed out strips of bone for shoeing the runners of the sledges. In fact, everything that can be cut off from the whale, before the carcass sinks or is carried off by the current, serves some useful purpose.

The most favorable time for whaling is when there is a continuous "lead" of open water, not more than a couple of hundred yards wide, with a solid pack of ice beyond it. Then the whales must pass up within sight or hearing of the boats. When the open water is very wide, the whales may pass at a distance unnoticed, or so far off that it is impossible for a boat to overtake them.

If there is much loose ice, the crafty animals take advantage of it, and come up to breathe at little holes among the floes where a boat can not reach them.

As the season advances, the whales grow scarcer, and the whalemen relax their vigilance and pay more attention to the capture of seals, which they shoot through the head when they rise near the boat, securing them with light harpoons before they have time to sink. At this season, also, the whale-boats some times capture walrus and white whales.

At length several days pass without a whale being seen, and one by one the crews give up looking for them and bring home their boats, until by the first of July the whaling is over for the year, the boats are all in, and everybody is preparing to leave the village for the summer excursions.

SKETCH OF DANIEL GARRISON BRINTON.

By Dr. CHARLES C. ABBOTT.

A FEW years prior to the widely spread interest in American archæology that is now taken, there was published in Philadelphia a small duodecimo volume of two hundred pages entitled Notes on the Floridian Peninsula, concerning which its author states in his preface, "The present little work is the partial result of odd hours spent in the study of the history . . . of the peninsula of Florida." A "little" book, in one sense, it is true, but far from it in all others, and it remains to-day our best *résumé* of the archæology of that wonderful peninsula. The author of this volume, but twenty-two years old at the time of its appearance, is the subject of the present sketch—Daniel Garrison Brinton.

Dr. Brinton was born May 13, 1837, at Thornbury, Chester County, Pa., and is of English descent on both the paternal and maternal side. His ancestor, William Brinton, came from Shropshire, where the family had lived for many generations. He became an early member of the Society of Friends, and emigrated to the colony of Pennsylvania in 1684. His descendants have generally continued their attachment to Quakerism.

The life-long interest which he has taken in the study of the American Indians may have been owing to the fact that on his father's farm was a "village site" of some ancient encampment of the Delaware Indians. Many a day of his boyhood was passed in collecting from this and similar localities the broken arrow-points, the stone axes, and the fragments of pottery which marked the presence of this older and mysterious race. The study of McClintock's Antiquarian Researches, a now almost forgotten volume, fixed and expanded this taste. The work, however, to which he attributes beyond all others a formative influence on his youthful tastes was Humboldt's Cosmos, the English translation of which by Colonel Sabine was his favorite reading at the age of fifteen and sixteen. The poetic hues in which this great master knew how to garb the dry facts of science, and the wonderful skill with which he developed the intimate relationship of lower and inorganic existence to the thoughts, aspirations, and destiny of man, stimulate the imagination with the force of a great epic.

Dr. Brinton graduated at Yale College in 1858, and studied medicine in the Jefferson Medical College, Philadelphia, where he took the degree of M. D. in 1860. After a year, spent chiefly at Paris and Heidelberg, he was recalled by the events of the war and entered the army as Surgeon of United States Volunteers. After serving in the field as Medical Director of the Eleventh Army Corps, he was sent to Quincy and Springfield, Ill., as superintendent of hospitals, where he remained until the close of the war. In 1867 he was tendered the position of editor of the Medical and Surgical Reporter, at that time the only weekly medical journal in Philadelphia. This position he held uninterruptedly until 1887.

In 1884 he was appointed Professor of Ethnology at the Academy of Natural Sciences, Philadelphia, and in 1886 Professor of American Linguistics and Archæology in the University of Pennsylvania. At both the institutions named he delivers a course of lectures every winter, which are highly appreciated by the public, as the numbers attending them attest. His subject-matter, being both ethnologic and archæologic, necessarily covers an enormous field; but Brinton very successfully exercises the faculty of conciseness, yet never at the expense of lucidity.

Dr. Brinton's contributions to scientific literature began, as already stated, in 1859, when he published The Floridian Peninsula, its Literary History, Indian Tribes, and Antiquities, the result of some months' travel in that State. His next work of importance was The Myths of the New World: a Treatise on the Symbolism and Mythology of the Red Race of America (New York, 1868; second edition, 1876). Other volumes which have appeared from his pen are The Religious Sentiment, its Source and Aim: a Contribution to the Science of Religion (New York, 1876); American Hero Myths: a Study in the Native Religions of the Western Continent (Philadelphia, 1882); Essays of an Americanist (Philadelphia, 1890); Races and Peoples; Lectures on the Science of Ethnography (New York, 1890); and has now in press a work entitled The American Race; a Linguistic Classification and Ethnographic Description of the Native Tribes of North and South America. It is the first attempt ever made to classify all the Indian tribes by their languages, and it also treats of their customs, religions, physical traits, arts, antiquities, and traditions. The work comprises the results of several years of study in this special field.

Of the ethnological papers by Dr. Brinton the National Legend of the Chahta-Muskokee Tribes, Notes on the Codex Troano, The Lineal Measures of the Semi-civilized Nations of Mexico and Central America, On the Xinca Indians of Guatemala, and The Books of Chilan Balam, are specially prominent, as are the strictly archæological papers, such as The Probable Nationality of the Mound-builders, in which the author favors the theory that the mound-builders of the Ohio Valley were of the same race as the Choctaws, and probably their ancestors; On the Cuspidiform Petroglyphs, or Bird-track Sculpture of Ohio; and the later Review of the Data for the Prehistoric Chronology of America. Dr. Brinton has given attention, too, to folk-lore, as a subject worthy of scientific treatment, and published The Journey of the Soul, a comparative study of Aztec, Aryan, and Egyptian mythology, and also The Folk Lore of Yucatan.

This goodly list, of which any scientific worker might well be proud, if the results of a long life, by no means covers the ground of Brinton's scientific and literary activity. He has been both publisher and editor of the Library of Aboriginal American Literature, of which eight volumes have appeared, six of which are edited by Brinton. The titles, given in order of their publication, are: The Chronicles of the Mayas, The Comedy-Ballet of Güegüence, The Lenâpé and their Legends, The Annals of the Cakchiquels, Ancient Nahuatl Poetry, and The Rig Veda Americanus. These works are all of unquestionable merit, notwithstanding they have been subjected to considerable adverse criticism. This is not to be wondered at, as works of this character, if edited in a pronounced manner, by one having strong opinions that are plainly expressed, are sure to meet with some opposition, which reflects, however, nothing upon the skill with which they are edited, and is, we hold, a pretty certain indication of their value as contributions to knowledge. Were further testimony to this wanting, it is shown in the fact that this series obtained for its author the prize medal of the Société Américaine de France; this being the only instance in which it has been decreed to an American writer.

In linguistics Dr. Brinton has published during the past two decades, Grammar of the Choctaw Language, by Rev. Cyrus

Byington, edited by Brinton; Contributions to a Grammar of the Muskogee Language; The Ancient Phonetic Alphabet of Yucatan, describing Lauda's so-called Maya alphabet; The Arawack Language of Guiana, in which the author shows that the nations of the Bahamas and Antilles at the discovery were of the Arawack stock; this essay contains an analysis of the primitive language of Hayti On the Language of the Natchez, wherein the writer identifies the language of the Natchez as largely a dialect of the Chahta-Muskokee family; the Names of the Gods, an exegetical study of the *Popol Vuh*, or national book of the Quiches of Guatemala; A Grammar of the Cakchiquel Language of Guatemala; American Languages and why we should study them; The Philosophic Grammar of American Languages, as set forth by Wilhelm von Humboldt, with the translation of an unpublished memoir by him, on the American verb; On Polysynthesis and Incorporation; Notes on the Manque, an extinct dialect formerly spoken in Nicaragua; The Taensa Grammar and Dictionary, in which are shown the fraudulent claims of the alleged Taensa language, introduced by Parisot; The Study of the Nahuatl Language; The Phonetic Elements in the Graphic System of the Mayas and Mexicans; The Conception of Love in some American Languages; On the Ikonomatic Method of Phonetic Writing; and, in 1889, associated with Rev. Albert Seqaqkind Anthony was issued a Lenâpé-English Dictionary, based upon a manuscript of the last century, preserved in the Moravian church at Bethlehem, Pa.

In general linguistics he has contributed several papers to the Proceedings of the American Philosophical Society on the possibility of an international scientific tongue, the chief arguments in which were summed up in a pamphlet published in 1889 on the Aims and Traits of a World-Language.

In the great conflict between scientific thought and religious dogma, Dr. Brinton has always occupied a pronounced position. His volume on the Religious Sentiment begins by an absolute rejection of the supernatural as such, and explains all expressions of religious feeling as the results of familiar physical and mental laws. These opinions he further emphasized in an address on Giordano Bruno, published in 1890, a philosopher to whose theories he had paid considerable attention in early life.

While singularly devoid of taste or faculty for music—which may perhaps be attributed to six generations of Quaker ancestry—Dr. Brinton has always cherished an ardent love of poetry. He is Vice-President of and a frequent contributor to the Browning Society of Philadelphia, which numbers nearly seven hundred members; he is also a friend and disciple of Walt Whitman, and has published an essay explaining his eccentric versifications.

In November, 1889, the Archæological Association of the University of Pennsylvania was organized, and Dr. Brinton at once became a leading spirit in its councils, and by personal labor and influence materially advanced its progress. The formation of a museum is necessarily slow work, and too often fails through misdirected energy; but this has not been the fate of the undertaking in question. Looking upon such a museum as valuable in proportion to its collections being the result of exploration intelligently conducted, Brinton insisted, from the very outset, that by such means, rather than by the purchase of collections or single specimens, should the work be carried on. His wise counsel has prevailed, and as material for the illustration of archæological lectures, the university now possesses hundreds of objects of which every available fact with reference to their history is known.

Dr. Brinton's scientific work covers so broad a field that it is difficult for any one person to follow him wheresoever he leads; but if it be a safe guide to accept the general trend of criticism among archæologists, ethnologists, and those learned in linguistic lore, he has touched upon no subject without throwing light thereon, and to-day, still young in years and vigorous both of mind and body, is preparing for further labors. American science and American letters may be proud of such a worker, for his position, both as a scientist and a *littérateur*, is no uncertain one.

Besides the two positions that he holds in Philadelphia, to which reference has been made, Dr. Brinton is President of the American Folk-lore Society and of the Numismatic and Antiquarian Society of Philadelphia; member of the Anthropological Societies of Berlin, and Vienna, and of the Ethnographical Societies of Paris and Florence; of the Royal Society of Antiquaries, Copenhagen; the Royal Academy of History of Madrid; the American Philosophical Society, the American Antiquarian Society, etc.

The aboriginal race of Tasmania, of which only a single survivor remains—if she be really of pure blood, which is doubted—was one of peculiar interest, for it continued down to our own times at a degree of culture hardly equal to that of the palæolithic flint-workers. The making of rude stone implements and of baskets were almost the only arts they possessed. They made fire by the stick and drill; for ornaments they had strings of shell; and for weapons only the spear and the *waddy*. Their huts were slight, and they had no knowledge of agriculture. Dr. Tylor says that their life may give some idea of the conditions of the earliest prehistoric tribes of the Old World, except that they had a milder climate than the others and no large animals, and were in some arts rather below them. All the information respecting these people has been collected by Mr. H. Ling Roth for his book upon them.

EDITOR'S TABLE.

KOCH'S CONSUMPTION-CURE.

THE very great importance of the subject of the cure of consumption, the enormous extent of the malady and its great fatality, would naturally be the means of attracting universal attention to any remedy which was supposed to possess curative powers over it. To one who is familiar with the writings of Koch on this subject it need not be said that he is not properly to be held responsible for the exaggerated ideas which have been received of the efficacy of the new agent; nor, indeed, are any of the numerous scientific men who have carefully observed its effects in different countries. But many visionary persons in the medical profession, and many not in it, became imbued early with the impression that there had at last been found a means of working miracles. Moreover, a few designing and unscrupulous doctors intentionally aided, to a slight extent, in the propagation of this idea; but probably the most generally operative cause of the exaggerated notions that have obtained with regard to the potency of the new remedy lies in the popular inclination toward a belief in the supernatural. People who wish to be deceived often begin by unintentionally endeavoring to deceive themselves.

That the public should derive an idea of the potency for good of this remedy far beyond what Koch has ever claimed for it, or what any experience with it would warrant, is not surprising—such has often been the case before with new and relatively untried remedies. Not only the public, but the doctors, are often deceived by the heralding of new cures. It is but a few years since the benzoate of soda was published by reputable physicians in high places in Austria as a means of curing consumption. Medical literature teemed with accounts of its powers for a few months, and then it sank rapidly into oblivion. A few years later there came to us from the Riviera most startling accounts of cures of consumption and various other pulmonary diseases by means of the introduction into the blood of sulphureted hydrogen dissolved in carbonic acid. These accounts were most circumstantial, and the truth of them was vouched for by several men of good standing in the medical profession. So brilliant were the results claimed that the method of treatment soon became common. Many doctors tried it in many cities, and after a fluctuating existence of a few months the Bergeon treatment, as it was called, quietly died and was decently interred among many other therapeutic procedures that had once had their day. Some years ago the world was startled by the assertion that in South America a cure for cancer had been found in the bark of a climbing plant called *condurango*. The sensation created by this announcement is remembered by many doctors who are still young. It was tried in that year here and in various European capitals, and was discarded as inert and useless. Condurango was then supposed to be dead as a therapeutic agent beyond all possibility of revival, when suddenly the serenity of the medical world was again rudely shocked by a publication which emanated from the Professor of Medicine in the University of Heidelberg, two years later, in which he reported the cure of a cancer of the stomach by the use of this drug. Since then evidence has accumulated to show that condurango does seem to possess a curative power in some forms of cancer of the stomach; but it is known to be inert as regards cancer elsewhere. It would be easy to adduce evidence in favor of the importance of receiving encomiums upon new and marvelous cures with the utmost caution.

It can not yet be said that the exact status of Koch's remedy is fixed; nor can we even yet say with certainty that this much-heralded cure is destined to survive among established methods at all. The most that is claimed for it by its most ardent advocates is that it seems capable of depriving the bacillus of the material in which it thrives best—i. e., of disintegrating and destroying tuberculous tissue. There has been no claim that it has any direct effect upon the existence of the bacillus, nor that it, having deprived the bacillus of its food, tends in any way to remove that parasite from the body, and thus to eliminate the possible source of danger of subsequent or more general infection. Under its influence in some forms of local tuberculosis — especially of the skin — it has been shown that tissue which was of the very lowly organized variety characteristic of the disease has been at first in part and then wholly replaced by a tissue of higher organization, and one that is likely to be permanent.

In regard to tuberculosis of the lungs, there can be no question that improvement in the patient's general condition and also evidence of improvement at the site of the disease have followed the use of this remedy. The general improvement manifests itself by a gain in weight, lessening of fever, increased appetite, better sleep. The local improvement is surmised from certain changes to be observed by auscultation and percussion, together with a diminution in the severity of the cough and in the amount of the expectoration, and also a diminution in the number of the bacilli in the expectoration or their complete disappearance from it. This has not always been the case. In not a few instances no improvement has resulted, and in other cases direct and most damaging results, including hæmorrhage and even death, have been brought about by it. In the treatment of tuberculosis of the bones and joints results seem to have been widely different. It is certain that some cases have been benefited, and equally certain that others have not.

Quite startling testimony to the possible causation of bad effects in a miscellaneous group of cases has recently been adduced in Berlin. This testimony is in the shape of the results of twenty-one autopsies made by Prof. Virchow of the bodies of patients who had been treated by Koch's fluid. Of these twenty-one cases sixteen were cases of consumption in the ordinary sense—that is, cases in which the disease was either wholly or chiefly in the lungs. The others included bone disease, chronic pleurisy, and tubercular meningitis. Some of the diseased changes described in important tissues and organs—in the lungs, heart, brain, intestines, and elsewhere, which can be directly ascribed to the influence of the "lymph"—make one feel that the remedy is quite as potent for evil as it is for good. Some of these effects were very disastrous in their results, even though the cases had, as a rule, been carefully selected by competent physicians as being appropriate subjects for the new treatment. Virchow shows how the process of consumption in the lungs can be made to spread and involve greater areas by the gradual loosening of masses of tubercular tissue from their original sites and their transference elsewhere. He shows how the disease in the larynx can be caused to take a sudden and very serious turn in consequence of the local swelling produced by the treatment. This may be so great as to prevent the entrance of air to the lungs, and cause death at once by suffocation. He shows how a fresh eruption of tubercles may be caused by it, and demonstrates their presence in the coverings of the brain and of the heart and elsewhere. He explains these occurrences by the hypothesis that the new remedy is capable of disturbing a localized tubercular focus and setting free the virus of the disease under such circumstances that it is capable of disseminating tubercle in other parts. He also shows that it is capable of causing intense congestion and hæmorrhage. Virchow is not the only critic of Koch's method, though he is the most prominent one. Others in Berlin and elsewhere have related cases in which the disease extended while the patients were under treatment.

No one who has tried it carefully at all questions its powers; but the most competent observers agree that its general or indiscriminate employment would be most unsafe. Furthermore, competent observers here have concluded that, even though the cases be selected ever so carefully, if the dose of the fluid be not most accurately adjusted to the condition of each individual case, serious general disturbances may be caused and local changes at the site of the diseased tissue may be so marked as to produce dangerous results. These results are among those described by Virchow as due to the sudden dislodgment of tubercular masses in the lungs of such large size that they can not be coughed up, and their falling into more dependent places in the lungs and becoming lodged there and giving rise to new infection which may develop rapidly.

On the whole, it seems fair to say that before conclusive results can be obtained in the treatment of so chronic a disease as consumption time must elapse—time measured by months or years—before the present method can be said to have been thoroughly tried and assigned to its definite place in the therapeutic armamentarium. It may be a boon to mankind in comparison with which vaccination is a trifle; and it may yet be relegated to the dimly lighted region where rest many once promising methods whose day is long since forgotten. Meanwhile the treatment of consumption is by no means hopeless without Koch's fluid. Exactly the kind of cases that are doubtless often capable of being benefited by it have long since been known to be greatly improved and often cured by hygienic and dietetic treatment. It is within the experience of the writer that several such cases have been permanently cured at the Saranac sanitarium in the Adirondacks when they seemed to be gravely ill and after they had developed some of the symptoms which are usually regarded as most alarming. Many other equally good resorts are to be found in elevated regions in different parts of the country. Many cases that are not permanently cured in these mountainous regions are greatly improved, so that life may be indefinitely prolonged if one is willing to make his home considerably above sea level. It is a matter of common experience to every pathologist to find in the bodies of people who die from widely different causes, often in those who die from surgical injuries or accidents, perfectly unmistakable evidence of consumption. Old tubercular deposits in the upper parts of the lungs are exceedingly common in people who ceased to cough or present other symptoms of the disease years before they died. In many of these cases no especial care could have been taken, certainly no systematic and intelligent treatment could have been followed, for these patients die in hospitals after long lives of toil, privation, hardship, or excesses. Thus not only is the disease often curable by care, as we have said, but it often gets well wholly without care and even without proper food and shelter. In the absence of positive proofs of the general efficacy and safety of the new treatment, and in view of the fact that it is still accessible to but very few of our consumptives, those who are threatened with consumption or who are actually suffering from it should not allow their hopes of relief by the new cure to take the place of those hygienic measures which, if rightly applied, may serve to ward off many of the most serious symptoms of consumption, and sometimes even to cure the disease.

INTELLECTUAL LIBERTY.

The recent prosecution of the Rev. Howard MacQueary for heresy has brought out in a striking manner the fact that the sympathies of the public in a case of this kind are, as a rule, strongly with the defendant—with the man who is striving to obtain recognition for intellectual rights as against arbitrarily imposed dogmas. We do not say that the prosecutors in such a case are to be blamed. Their motives may be, and doubtless in general are, of the purest, and their logical position may be very strong. Still, they labor under the disadvantage of administering and striving to enforce a system in which authority takes the place which, in other fields of thought, is only assigned to proved and still provable results of investigation. Long ago men were led to think and believe so and so: no otherwise must they think and believe today. Such is the principle that governs adhesion to theological standards—a principle that has had its uses in past times by giving stability to institutions under which the forces of society were being organized and the sympathies of men developed. Manifestly, however, this principle is becoming more and more out of harmony with the spirit of the age. Men now know that, apart from constant—not reassertion, but—reverification, the opinions of their ancestors are not to be depended on for guidance; and they do not see why this should not apply as much in the theological region as in any other. The creeds *may be all true*, and it is certainly no part of our business to say they are not; only in these days it is almost impossible for intelligent men not to hold them subject to such verification as their nature and alleged evidences admit of. Subjective impressions, we all know, are just as liable to error as objective ones; and because a man, many centuries ago, held that he had received a supernatural communication we can not feel absolutely certain—unless collateral proofs of considerable cogency are forthcoming—that he really received such a communication and was not under the influence of illusion. In saying this, our object is not in any way to weaken the hold which theological doctrines may have upon any mind, but merely to explain how it is that so much public sympathy seems to be accorded to those who seek to escape from what, to them, has become the bondage of authority. In our institutions of secular learning the putting forward of a new theory or the discarding of an old one, far from subjecting a man to forfeiture of office, gives a certain additional interest to what he has to say, and he is allowed the freest possible scope for developing his thought and his conclusions. Of course, he must run the gantlet of criticism; but this is just what a man who thinks he has discovered new truth desires. We do not blame our ecclesiastical friends for not acting at once on similar principles, for we know they can not do so, and we are very ready to believe that many of them at least, if not most of them, are doing the best they can in their several positions, and acting fully up to their lights. But none the less do we maintain that verification is the only charter on which beliefs of any kind can be properly or safely held, and that this truth must eventually be recognized in every field of thought and speculation.

LITERARY NOTICES.

Socialism, New and Old. By William Graham, M. A., Professor of Jurisprudence and Political Economy, Queen's College, Belfast. International Scientific Series. Vol. LXVIII. New York: D. Appleton & Co. Pp. lv + 416. Price, \$1.75.

The latest addition to the International Scientific Series is a very timely one. The subject of socialism or social reconstruction is in the air; and a competent thinker, who has any well-matured views on the question, is sure of an attentive hearing. Prof. Graham, in the work before us, deals with the subject of socialism, first historically, then critically, and lastly constructively. From first to last he holds the attention of the reader by the vigor of his style and his own manifest interest in the important questions at issue. The thorough impartiality of his attitude also compels admiration. The object he has set before himself is to discover in what points the present constitution of society is faulty, and what promise of better things the different socialist programmes now before the world contain. Considering that he is an exponent of what is so often spoken of as "the dismal science," the energy with which he arraigns the vices of the existing social order and the sympathy he expresses for the unhappy victims of an excessive competition may appear surprising; but the fact is, that political economy to-day is not content with recording facts and indicating the laws of which these facts seem to be the expression and proof, but aims at showing what ought to be as well as what is. It no longer confines itself to the question, How is the maximum of wealth to be produced? or, What motives sway men in the pursuit of wealth? It inquires into the general conditions of social well-being; it wants to know how far it may be possible to check that reign of universal cupidity on which the older economists seemed to count as an unalterable attitude of the human mind; and it asks searching questions as to the nature and requirements of justice between man and man. The one thing to dread in connection with this new departure of political economy is a possible lapsing into sentimentalism The wider the scope it allows itself the more rigorously should it adhere to strict scientific method. There is nothing weakly sentimental in the tone of Mr. Graham's book, and yet it hardly appears to us that he has given due recognition to some of the severer aspects of the problem with which he is grappling. "Man's inhumanity to man," as we all know, has been a dark feature in past history; but is it not the case that Nature itself, in the production of imperfect individuals—imperfect from the social point of view, and taking into account the present development of civilization—is primarily responsible for a large, if not the larger, part of the troubles with which we are contending to-day? Every one in the least familiar with the doctrine of natural selection knows that if different species are kept up to a certain standard of efficiency, it is due to the disappearance in the struggle for life of the more poorly endowed individuals that come into existence. Among mankind, if even the *most* poorly endowed perishes from want, our whole civilization is considered to be disgraced. This is a point which certainly requires very careful consideration, not only in connection with the criticism of existing institutions, but also in connection with any plans which may be formed for the improvement of our social organization. There is no use in trying to fight against Nature; the only thing to do, when we clearly recognize the incidence of a natural law, is to see how we can best convert it to our uses or turn aside any injury it may threaten to our interests. Thus, having recognized the fact that, by the operation of the simple law of variation, Nature will produce imperfect individuals, ill-adapted to their environment and destined in all probability to be a drag on the society in which they have a place, the question arises how to deal with them; and that question ought to be very fairly and fully met.

But, supposing even that all individuals produced were of average quality, how does the law of population bear upon the social question? How far are our social troubles the result of an undue rate of increase in population? It is true that there are large tracts of the earth yet unoccupied, but the *vis inertiæ* of mankind counts for something; and it does not follow because there is still room for settlement that any given rate of increase might not be in excess of the available means for spreading population over the face of the earth. In early ages tribes used to swarm very much like bees; but in those days men were not particular where they found their new abodes, or whom they dispossessed, or otherwise disposed of, in doing so.

Looked at from certain points of view, competition seems a terrible thing; but is there any certainty that the world could do without it? The successful and the less successful or unsuccessful alike are impelled by it to exertion; it keeps the world at work, and so far helps to make the world happy. What would come from any marked relaxation of the law that forces us all to keep our faculties in exercise it would be difficult to say; but, taking into account what we know of average human nature, we can hardly predict that the effect would be good. It is easy to find fault with Nature, but not so easy to put her aside and do the work that she is doing. There are few intelligent men who do not recognize what an advantage it is to them to be, in many things, under the law of necessity; and probably also there are few who have much reason to pride themselves on what they have done wholly apart from any such pressure. When a man may either do a thing requiring effort or leave it undone, the chances that he will do it are not overwhelmingly great.

Mr. Graham criticises very effectively the wilder suggestions of socialistic writers, but he does not hesitate to express his opinion that a certain infusion into legislation and government of the socialistic spirit and of socialistic methods is a present necessity. "The state," he says, "has great power: through its laws and institutions it can affect the relations of classes. It can temper great inequality. It can mitigate poverty. It can check the strong oppressor. It can protect the poor, their health, their lives, their property. Many of these things it has already done to some extent, and it has shown an increasing tendency, within the past forty years, to interfere in order to protect the feeble workers and to restrain unscrupulous employers. . . . Its duty is more than the protection of life and property. It has to make just and beneficial laws respecting property. It is its duty to enforce contracts; but it may also be its duty to narrow the sphere of contracts in certain cases where the contracts can not really be free." He draws a fearful picture of what would have happened in England had it not been for the interference of the state in the passing of factory laws and other similar acts. "We should have had a proletariat of servile workers, degraded in physique, in mind, in morals; mothers working in mines and factories, their sickly children dying without a mother's care, or surviving with enfeebled frames; other children ignorant and lawless, worked to death or growing up savages; the whole laboring population turned into mere human plant and instruments to make the fortunes of masters, constantly becoming more insolent and inhuman from impunity. We should have had the slave gangs of the Roman Republic repeated, only that the slaves would have been the countrymen of their masters, neither conquered in battle nor born in slavery." This is strong language, and to some the conclusion may appear somewhat too dogmatically stated. Some such idea, we think, must have occurred to the writer himself, for he hastens to add, "That is a deducible consequence, had the system continued in its strictness and the hands submitted." It is worth recalling that so judicious and philanthropic a man as the late John Bright was of opinion that the factory laws had done more harm than good. Prof. Graham's book is one that ought to be widely read, as we are persuaded that, whether the writer's own conclusions are accepted or not, his candid and able discussion of the various questions comprised under the general head of "Socialism" can not fail to be helpful and beneficial.

The Draper Catalogue of Stellar Spectra. Photographed with the Eight-inch Bache Telescope as a Part of the Henry Draper Memorial. Astronomical Observatory of Harvard College, Edward C. Pickering, Director. Pp. 388.

This volume contains a catalogue of the photographic spectra of 10,351 stars, nearly all of them north of 25° south declination. Six hundred and thirty-three photographic plates are discussed and 28,266 spectra measured. Exposures of about five minutes were generally used for equatorial stars, and somewhat longer exposures for northern stars. Photographic plates eight inches by ten were employed; and at each exposure the spectra were obtained of all the stars of sufficient brightness in a region of 10° square. All stars brighter than the seventh magnitude would generally give images of sufficient intensity to be measured, unless they were of a reddish color. Many stars of the eighth magnitude or fainter appeared on the plates with sufficient distinctness to be included. The total number of spectra on a single plate sometimes exceeded two hundred. The plan of work was such that the entire sky north of 25° S. was covered twice in the first cycle of photographs. The plates overlapped, so that a spectrum which appeared near the corner of one plate would appear near the center of another. The work was then repeated by a second similar cycle of plates. Each star should, in general, appear on four plates. Owing to the overlapping of the regions and the repetition of plates which were not satisfactory, this number is greatly increased for many of the stars. The faintest stars appear on only one plate. In this case a second independent measure was always made. Eight type photographs of as many stars are given in the frontispiece to the volume. But the general appearance of a copy of a photograph varies so much with changes in exposure and development that it is difficult to convey an idea of the original negative by a paper print.

Guides for Science Teaching. No. VIII, Insecta. By Alpheus Hyatt and J. M. Arms. Boston: D. C. Heath & Co., Publishers. 1890.

The teachers are again under obligations to Prof. Hyatt and also to his coadjutor Miss Arms for the admirable Guide which is now before us. One follows a path laid out by this distinguished naturalist sure that he will have no pitfall in the way. He does not start on a road that is just six weeks long, but finds a broad avenue, with here and there places where he can use his own powers of observation and perhaps find a shorter cut. As stated in the preface, the Guide is a series of replies to questions which have arisen in the minds of its authors while teaching. "Teacher and scholars should recognize that science is infinite, and demands from all its votaries a modest acknowledgment of this fact. They should work more as companions learning from each other's observations, and less as teacher and pupils, than in those studies which can be taught from written treatises." The Guide is illustrated by 223 figures, derived from the highest sources or drawn from originals, and presents the latest knowledge concerning the structure and classification of insects. To an old-time entomologist it will seem odd to find other groups raised to the dignity of the seven well-known orders, for now we have to face sixteen orders. This, after all, simplifies the work of analysis. A unique diagrammatical plate, showing the probable origin of the different orders and their relation to each other; a synopsis of the contents; a list of letters and signs which are uniform throughout the book; and an exhaustive index at the end combine to make the work an indispensable guide to the study of insects.

Higher Education of Women in Europe. By Helene Lange, of Berlin. Translated and accompanied by Comparative Statistics by L. R. Klemm, Ph. D. International Education Series. Edited by W. T. Harris, LL. D. New York: D. Appleton & Co. Pp. 36 + 186. Price, $1.

In this work, those interested in the higher education of women (and who out of Germany are not?) will find a most rational treatment of the subject.

In the editor's preface attention is called to the changed condition of women by the advent of labor-saving machinery, which has taken the old hand-labor from thousands. Multitudes who were formerly occupied are stranded for want of something to do. The incompetent become paupers. This condition presses harder upon the women, and avenues of rough industry which are closed against them drive them to immoral lives. It is believed, and with good reason, that, if every avenue of work was opened equally to women, different results would follow.

The figures given by Dr. Klemm show that the question of the higher education of women is no longer a problem in this country, and England is fast following our example. In other European countries, notably in Prussia, the case is far different, and in the one occupation for which women are eminently fitted, that of teachers, not more than ten per cent are found in this field, as compared with the United States, where sixty-three per cent of the entire number of teachers are women; taking the cities of the United States alone, over ninety per cent are women. Now, either one of two things is to be noted from these figures—either we are committing a colossal blunder or the Germans are.

Miss Lange says: "The English teacher and principal enjoys unquestioned authority, externally and internally. In German public girls' schools the older students know, or instinctively feel, that the education of the female teacher, obtained in a normal school, is despised by the male teachers who obtained theirs in the university. It is too obvious that the women are found only in subordinate positions (exceptions not counted) of the school organism. No wonder that the pupils sometimes refuse them the respect which is offered as a matter of course in England, where the female teachers are provided with the highest professional education." Quoting again, she says: "In France there were no preparatory schools for the university. Only after the downfall of the second empire, after the humiliating experiences in 1870–'71, steps were taken favorable to women. The Government became convinced of the fact that an elevation of the whole people is only possible by means of an elevation of its women. The motion of Camille Sée to found and maintain lyceums for women was adopted without delay. 'Our law is a moral as well as a social and political law'—thus he pleaded for it, in 1880, before the Chamber of Deputies—'it concerns the future and security of France, for upon the women depends the greatness or decay of the nations.'"

In Portugal "the question of establishing special girls' lyceums is being agitated; a violent controversy has been going on concerning this, and the desire of many Portuguese is that 'their ladies may remain in future as charmingly amiable and foolish children as they have been since Adam's time.'" "Clemens Nohl speaks in his Pedagogy for Higher Schools of the absolute necessity to grant the female sex a thorough education, and says the mother needs it for the sake of her family, the unmarried woman for her own sake."

One forcible argument which is not urged by Miss Lange comes to one when he realizes how much work is done by women in the post-office, telegraph, and other public departments in England, or, if he chances to pass the Treasury and other departments in Washington at the noon hour, and sees the thronging thousands of women pour out from these buildings, he feels that, in case of war, hardly a man would be needed at home to carry on the minute details of office work. The Landwehr and the Landsturm could march out to a man, and not a wheel of government machinery would be checked in its movement. Germany, in this respect, is still in the Oriental stage, and it behooves her public men to look into this matter from the standpoint of military strength. Certainly such an argument might reach her, despite the uniform brutality which marks a German's attitude toward women as contrasted with their treatment by other nations.

A Washington Bible-Class. By Gail Hamilton. New York: D. Appleton & Co. Pp. 303. Price, $1.50.

The story of the Bible-class is told in an introductory chapter. A mother in Washington, embarrassed by the refusal of her sons to accept certain doctrines as they are held by the theologians, and finding it equally embarrassing to teach them what her reason could not approve, consulted with other mothers about the religious instruction of their children. The end of the consultation was the formation of a class to study the Bible, not with reference to speculation, but to find the truth in it; not what there might be of Calvinism, or Lutheranism, or agnosticism, or Catholicism, or Universalism, but what is Scripture; not what men say Scripture says and means, but what Scripture itself means and says. "The class, as it grew, embraced members of the families of the Cabinet, of Congressmen, diplomats, scientific and literary men, etc., and persons of a great variety of shades of belief. The class was at first intended to be conversational, and its idea one of common study, comparison of results, and general conference"; but the woman who was chosen leader soon found herself doing most of the talking, and the proceedings, as they are presented in the book, took the form of lectures. The tenor of these lectures is what we might describe, without presuming to express an opinion or to approve or disapprove, as embodying a common-sense view of the questions that arose. The narrative is composed, as to its most remarkable passages, in an anthropomorphic state of mind, which sees God in everything, regards all phenomena as his direct act, and personifies him as the actor. It is assumed that the destruction of Sodom and Gomorrah was by an eruption of natural gas in that asphaltic region; that Lot was warned by a messenger who foresaw the eruption, and his wife lingered and was caught in a shower of saltpeter and sulphur. A parallel to the sun standing still in Joshua may be found in the red sunsets of 1883 and 1831, and other phenomena recorded in history. If the literal accuracy of the accounts is not established by this kind of reasoning, neither science nor piety need lash itself to fury over the explanations of literature. They are questions of literature. They are not questions of faith. It is science itself which forbids us to pronounce too confidently against even the literal truthfulness of the Bible. Many things which might be given up to legend without impairing the moral value of the Holy Scriptures, because God can be illustrated by a legend or a myth as well as by a fact, science and research seem to be basing upon a true historical foundation. "The rationalist must be wary with his myths, for the Egyptian explorers are at his heels." The natural possibility of the passage of the Red Sea is illustrated by citing the bar at Mount Desert, over which a retreating army might pass at low tide over to Bar Island, while the returning high tide should keep the pursuing army on Mount Desert; only it was the wind that played the part of the ebb tide at the Red Sea. In like spirit with these explanations the leader of the Washington Bible-class discoursed of the story of the Garden of Eden, of the Mystery of Melchisedek, of the Call of Abraham, of the Institutes of Moses, the Origin of Sacrifice, the attitude of Christ and the Apostles toward the Mosaic Institutes, Inspiration, the Atonement, Miracles, and various other knotty questions of doctrine.

Anales de la Oficina Meteorologica Argentina (Annals of the Argentine Meteorological Office). Under the Direction of Walter G. Davis. Vol. VIII, 1886. Buenos Ayres. Pp. 596.

The general course of the office corresponded with that of previous years. Numerous valuable observations were received from points well distributed throughout the republic, the results of which have been found useful in advancing the knowledge of climatological laws, for both practical and scientific purposes. New instruments have been added to the apparatus, or old ones replaced. Observations have been begun or renewed at six new stations, and reports were registered from twenty-three stations or separate observers. The system of observations at the central office has been greatly improved. The temperature of the soil has been taken at different depths down to twelve feet. The monthly means are given in the beginning of the report from twelve stations, of temperature, atmospheric pressure, humidity, pressure of atmospheric vapor, rainfall; and hourly means from the naval school and Cordoba, as well as temperature of the soil, wind direction and velocity, ozone, solar heat, and rainfall at Cordoba. The principal meteorological phenomenon of the year was the great snowfall and frost of the 19th, 20th, and 21st of September, which caused much injury to agriculture and cattle through the whole of the republic. Its history and course are traced from its origin in the Cordilleras, on the 16th, to the Atlantic. The director hopes that, with the advancing settlement of the country and the extension of means of communication and telegraphs, improvement may be gained in the knowledge of the laws of the meteorology of the country and the means of predicting changes of weather commensurate with that which has been realized in local observations. The volume is mainly occupied with the record of the detailed observations made at Villa Formosa (capital of the Northern Gran Chaco, two observers), the colony of Chubut, and the city of San Juan.

The Theory of Music. By Louis C. Elson. Boston: New England Conservatory of Music. Pp. 208.

This book is designed to furnish an outline for instruction in the fundamental principles of music. There is danger that the musician may become a specialist ignorant of the basis and framework of his art. The author has prepared this text-book as a help toward broader study. The general subjects treated are: Acoustics; The Orchestra; Rhythm and Notation; Musical Embellishments; Instrumental and Vocal Form.

The character of a vibration is first considered. The French define this as motion to one side only, but in England and America it includes the oscillation from side to side and back to the point of rest. Regular and continuous vibrations produce *music*; irregular vibrations result in *noise*. There are four laws or canons of the stretched string, depending upon its length, thickness, tension, and density. Vibrations become audible when they reach the rate of sixteen per second and vanish at the point of 38,000 per second. Overtones are likened to the wavelets which form part of a larger ocean wave. The sound-waves, however, divide with mathematical regularity, and the laws concerning them were first formulated by Helmholtz in 1863. The number and strength of overtones, or harmonics, cause us to recognize the difference between two instruments, as flute and violin, when sounding the same tone. The musical scale now in use arose to fit the needs of keyed instruments. The voice and stringed instruments can give the natural scale with many more intervals. Pitch has mathematical niceties, and its standard is a variable quantity. Philosophical pitch is determined by subdividing a wire that vibrates once a second. The variety of musical instruments has resulted from employing different vibrating substances, and from exciting vibration in these by several methods. Six classes of vibrations are noted: first, the vibrations of strings; second, of reeds; third and fourth, of elastic membranes; fifth, of solid elastic substances; and, sixth, "the vibrations of air upon itself in a confined space."

A consideration of orchestral instruments naturally follows. These are grouped as the string band, the "wood-wind," and the brass band. In each of these divisions are found four or more instruments that correspond to the soprano, alto, tenor, and bass in a vocal quartet. The modern orchestra dates from 1600; for, although the ancients used many instruments, they performed only unison-music, "while our idea of orchestral music is essentially part-music."

Rhythm, notation, marks of expression, and musical embellishments are fully illustrated. Musical form is next analyzed and traced to an origin in the old dances. The *suite* was "at first a set of dance-movements." In a study of figures and phrasing, the author points out that the *leit-motif* so characteristic of Wagner was first used by Mozart in Don Giovanni. Among the musical forms afflicted with changeable definitions is the symphony, now understood as a sonata for orchestra, but in the early part of the last century known as a prelude, interlude, or postlude. The development of the *sonata*, its various movements and dependent forms, follows, the more important of these being the concerto and classical overture.

The Catholic mass is named as the earliest vocal form. Some vocal forms are the offspring of instrumentation, such as the aria and rondo. Vocal music of any character may be written either in the strophe form, which repeats the music of one verse, or as an art-song, in which the music interprets the poem from beginning to end. The canon, the fugue, and, finally, modern dance forms are subjects of special study.

In conclusion, the author recommends to those wishing to become earnest musicians, ensemble-playing and score-reading. The German language should be acquired for the philosophy and literature of music, but Italian is most important to the vocalist. "Bach should be faithfully studied by every musician," since in him "the intellectual and emotional are so well balanced."

War and the Weather. By Edward Powers, C. E. Revised edition. Delavan, Wis.: Published by the author. Pp. 202. Price, $1.

A belief exists that heavy cannonading and great fires bring on rain. In some places it has been noticed often that a clear morning on the 4th of July has been followed by rain, and this has been attributed to the explosive celebration of the day. Mr. Powers has written his book to furnish definite evidence in support of the belief that rain can be produced by means of artillery, and to advocate the making of experiments by the Government in order to obtain certain proof in regard to it. His evidence consists of a record of those battles in our Mexican and civil wars in which artillery was largely used and which were followed by rain, giving the chief circumstances in each case. An appendix contains letters from army officers, transcripts from diaries, etc., supporting this record. In regard to the fact that artillery-firing does not always bring rain, the author says that the chief reason is that enough guns are not always brought into action and fired simultaneously, but there may be also minor reasons. He inserts an estimate of the cost of two experiments in which two hundred siege-guns should be used, making the amount $160,000 for the two. After this mode of causing precipitation had become systematized, he estimates that "a good rain-storm" would cost less than $21,000.

The Septonate and the Centralization of the Tonal System. By Julius Klauser. Milwaukee: William Rohlfing & Sons. Price, $3.

It is no exaggeration of the condition of an average musical student that Mr. Klauser describes in the introduction to this work. After pursuing the study of music for ten, fifteen, or twenty years, he may still be unable "to tell you what the intervals, chords, rhythms, and meters are that you dictate for oral discrimination." He has learned to use his voice or some instrument. His eye, hand, or vocal organs may be trained, but the cultivation of his ear has been left to chance. "Students are not taught, nor do they learn, to hear." A system of teaching which turns out pupils ignorant of the elements of their art, and liable to be embarrassed by simple questions, must be faulty. The author of this volume holds that there are two fundamental errors in musical training: one, the inverse method of instruction, in which a pupil is taught to perform before he can listen intelligently; the other, the usual presentation of the tonal system. As a remedy for the first, the beginner should be taught to hear exactly and discriminate from the start. A corrective for the second demands a reconstruction of our tonal conceptions. "The scale is too complex a unit; . . . its combinations are too multiple for any beginner to grasp as a whole." After much investigation of tonal relations and analysis of the mental process of musical reproduction, Mr. Klauser has fixed upon the scale-half or tetrachord, and the union of two scale-halves with a common central tonic, as simpler elements for tone-study. To the latter group of tones he gives the name of septonate, "seven principal tones in their natural positions," three preceding and three following a tonic. Other divisions of tones, which are the framework of the system, are the key-group and the tone-stratum. The key-group contains seventeen tones, consisting of the septonate and ten other tones; five sharps, called *up*-mediates, and five flats, the *down*-mediates. Ten more tones, named secondary intermediates, added to the key-group, complete the tone-stratum. A new theory for tone discrimination is introduced in the Principle of Progression. In hearing a series of tones, "we are disposed to progress on certain tones and to stop on others." The tones from which we feel a desire to move are called *by-tones;* those which create a feeling of rest are *harmonics*. The author explains these phenomena as the result of the antagonism or agreement which certain tones have with the melodic phrase already in mind, and which he calls "the governing voice."

The author argues the need of a new notation, and may hereafter attempt that Sisyphean task. Prefixed to this volume is an interesting and suggestive essay on a higher education in music. Some experiences in training children deficient in tone-sense deserve attention. The relation of music and mind is exhibited in the fact that music must be executed in a prescribed *tempo*—"the moments of cognition are limited." So "a concentrative power without parallel" is cultivated. In concluding the volume, various views of the origin of music are given, the author believing that music antedates speech, as the chromatic intervals of the wind and the melodious phrases of birds preceded the existence of man.

Elements of Crystallography. By George H. Williams, Associate Professor in the Johns Hopkins University. New York: Henry Holt & Co. Pp. 250. Price, $1.25 net.

This text-book, which is offered to students of chemistry, physics, geology, and mineralogy, contains as much of the subject as any one who does not intend to make mineralogy his life-work will need to know. It describes the several crystallographic systems, taking up a considerable number of the combinations possible under each, and giving diagrams and symbols. There are also chapters on Crystal Aggregates and Imperfections of Crystals, and an Appendix on Zones, Projection, and the Construction of Crystal Figures. To the student of mineralogy this will, of course, be an elementary volume; accordingly, a list of books is given, mostly German, in which fuller information can be found. There are 383 cuts in the volume.

Reader's Guide to Economic, Social, and Political Science. Edited by R. R. Bowker and George Iles. New York: Society for Political Education. Pp. 160. Price, cloth, $1.00; paper, 50 cents.

Within the past decade a very noteworthy increase of interest has taken place in economic, social, and political science. Its literature to-day flows in a stream many times as wide as that of 1881, and, passing the limits of the monographs and reviews specially devoted to it, now finds its way into popular magazines and leading journals. The quickening of interest which this denotes is not without a reason. Every year brings its enlargement of the functions of the state and some fresh appeal for yet wider extension of its scope. Interstate commerce is one of the more significant of its accessions of sway in recent years. It would seem that the guardianship of forests and the supervision of irrigation are to be among its duties in the near future. With authority in international trade to speak the word of good or ill fortune, Government is constantly being asked to step into the arena of domestic industry. Why may not the power which claims to bring prosperity by a tariff be invoked to regulate immigration, fix the hours of labor, or otherwise become as a Providence to the nation? With a literature teeming from the press treating these and allied questions—questions of the creation of wealth and its distribution; Government, and its relations to the commonwealth—such a guide as that provided by the Society for Political Education is clearly invaluable. Its editors present a classified list of the leading books, articles, Government and other reports, in the various fields covered by the manual. Each department has been revised by a competent specialist; and where, as in the case of free trade and protection, there are opposed camps, a representative of each has co-operated with the editors. The book is not a mere list, but a trustworthy guide, every work of importance receiving a brief descriptive or critical note. Prefixed to the several sections, wherever desirable, are a few lines advising the reader or student which books are best, and in what order they may most profitably be taken up. The titles have been selected not only from American and English, but from German, French, and Italian works. That foreign literature is very much richer than our own in economic and social science is a fact which this little book brings out very clearly. In emphasizing it, something will be done to broaden the outlook of American students, too often content with home authors not of the first rank. Lists for reading, elementary, intermediate, and advanced, are prescribed. The courses in politics and economics in leading American colleges for men and women are epitomized; and a very full index doubles the value of the book.

Those who have a taste for speculations on abstruse scientific questions will be interested in *Cosmical Evolution*, by *Evan McLennan* (Donohue, Chicago). It is a new theory of the physical universe, which substitutes for gravitation a system of bonds connecting the stars and planets as chemical atoms and molecules are assumed to be connected. The author's handling of the subject gives evidence of much ability.

Under the title *Manual of Archæology* Mr. *Talfourd Ely* publishes a sketch of ancient art (Putnam, $2). It is divided into two books, the first relating to Prehistoric, Egyptian, and Oriental Art, and the second to Greek, Etruscan, and Roman Art. The art of these countries is described as displayed in architecture, sculpture, engraving, painting, enameling, mosaic, and in the industrial arts. At the head of each of the eighteen chapters is a list of books recommended by the author for further reading. The work has an index, and contains one hundred and fourteen illustrations.

The *Third Annual Report of the Agricultural Experiment Station*, at Cornell University, covering the year 1890, comprises the separate reports of the several officers of the station, together with the collected bulletins that were issued during the year. These reports are largely devoted to descriptions of the buildings and laboratories that have been provided for the use of the station, illustrated with views and plans. The bulletins, most of which have been noticed in this magazine, deal with corn-growing, the examination and care of milk and cream, spraying plants, fruit-growing, tomatoes, insects injurious to plants, the clover rust, and a variety of minor investigations.

An Examination of Fingal's Cave, by *J. P. MacLean* (Clarke, 75 cents), is an account of this famous cavern enlarged from a report made by Prof. MacLean to the Smithsonian Institution in 1887. The island of Staffa contains several caverns besides the one of chief prominence, and these receive brief mention. The author's description of Fingal's Cave consists mostly of Sir Joseph Banks's account of his visit in 1772, which is inserted in full, and quotations from other sources. The origin of the cave is discussed, and reasons are given for not believing it to be the work of man. The volume is illustrated from drawings by the author and from other sources.

Harper's Sixth Reader (American Book Company, 90 cents) is devoted to British authors, and completes the series to which it belongs. Attention is called by the publishers to the gradation in the several classes of selections as they are herein arranged: those pertaining to modern history occur in chronological order, so also do the articles on Roman life and customs. Among the lessons are views of American institutions from English standpoints, examples of the best of British fiction and humor, and essays on questions of morals and personal duty. While many of the selections are new to school readers, a large number of acknowledged classics are also included. Both the living and the earlier writers are represented. Notes on the author and on the unusual words of each piece are appended.

The paper of Mr. *George M. Dawson*, of the Geological Survey of Canada, *On the Later Physiographical Geography of the Rocky Mountain Region in Canada*, is a monograph of a like order of those of which members of our own Geological Survey have produced a large number. Relating to what is virtually an extension into the British Provinces of the identical regions with which our own geologists are concerned, it may be grouped with their special memoirs as constituting one of a mass of materials by the aid of which American geology is being shaped into a more extensive, systematic, and harmonious scheme than has been applied to any other region. The western border region of the continent is defined by Mr. Dawson as being formed by a series of more or less nearly parallel mountain systems, with an average breadth in British Columbia of about four hundred miles, and tending in a direction similar to that of the Pacific shore line, the position of which in fact depends upon that of these orographic features. In traversing this generally mountainous zone—which the author calls the Cordillera belt—from east to west, we cross the Rocky Mountains; what may be classed together as the Gold Ranges (including the Selkirk, Purcell, Cariboo, and other ranges); the Coast Ranges; and an irregular mountain system—the Vancouver system—of which Vancouver Island and the Queen Charlotte Islands are unsubmerged parts. A region between the mountain and the Coast Ranges, without important mountain ranges, is referred to as the Interior Plateau of British Columbia. The paper has special reference to changes in elevation and the history of the Glacial period, and is divided into two parts: I. Mesozoic and Tertiary History; and II. Glacial History.

The Fruits of Culture is a comedy in four acts by Count *Leo Tolstoï* (Tucker, Boston). It deals with spiritualism, the principal scene being a bogus *séance*. The characters are Russian nobility, learned persons, servants, and peasants.

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POPULAR MISCELLANY.

Photographs in Aid of Road Improvement.—The New York and Connecticut divisions of the League of American Wheelmen have united in offering three prizes, of $50, $30, and $20 in gold, for collections of not less than three photographs showing the need of improved roads in the United States. The circular sent out by the committee states that the kind of pictures wanted are such as show a farmer's wagon and team hub-deep and knee-deep in a muddy road, break-downs caused by rough or muddy roads or steep grades, and, for contrast, those showing teams hauling loads over smooth, hard-surfaced roads. By this action the bicycle-riders show a readiness to do their share toward securing improvements that are important to all users of roads. Competitors' blanks and particulars will be sent by Isaac B. Potter, 278 Potter Building, New York, or Charles L. Burdette, Hartford, Conn. The competition closes May 1, 1891.

New Metric Standards.—Prof. Mendenhall exhibited at the last meeting of the American Association exact copies of the new metric standards received by the United States Government from the International Board of Weights and Measures. The standards, when received, were opened formally in the presence of the President and Secretaries of State and the Treasury and sixteen specially invited scientific men, and duly certified to, as was done with the standard troy pound during the administration of John Quincy Adams in 1828. The meter is a rod with H cross-section, made of an alloy of platinum and iridium. In making these standards for the various governments, two thirds of all the iridium known in the world was used. The extreme delicacy and exactness of the measurement work done upon the standards was illustrated by saying that when two of the standard kilogrammes were balanced against two similar masses, if one of the masses on one side of the balance was placed on top of the other mass, the balance would be destroyed. In other words, raising the mass of one kilogramme through less than two inches made a difference in the attraction of the earth readily observed.

Some North Dakota Mounds.—Mr. Henry Montgomery, between 1883 and 1889, excavated and explored thirty-nine ancient artificial mounds in North Dakota. They consisted of one beacon mound, one well-marked sacrificial mound and another not so well marked, and thirty-six burial mounds. The burial mounds were of two kinds. The ordinary burial mound consisted of a circular, rounded, or conical heap of earth, mostly rich, black soil from the prairie, clothed with grass, and rising generally to a height of several feet above the surrounding level. One or more vaults occur in each, in which human skeletons and various implements, ornaments, trinkets, etc., are found. A single vault is near the center; two or more vaults are found eccentric in situation, and at varying distances from one another. The vault is a circular, well-like pit, having a calcareous bottom and wall, and often also a calcareous covering. In digging for the vault—which was done systematically, a foot at a time, the level being carefully preserved—wood was found at the depth of about a foot, consisting of poles or young trees, varying in diameter from three to ten inches, charred at their ends and over the greater part of their surfaces. The skeleton was generally found in a crouching posture, with back against the wall and face toward the center. The second kind of burial mound is distinguished by having no wood and no burial chambers, and in the bones being broken and scattered. A third kind of mound, containing a layer of clay that seems to overlie many human skeletons, is hardly distinctly enough defined to be constituted a separate class. A well-defined sacrificial mound was explored by the author on the south side of Devil's Lake. Another mound, somewhat resembling this, was opened near Sweetwater Lake in July, 1889. A beacon mound in Beacon County was explored in September, 1887. The mounds are situated on high ridges and hills, composed often of drift clays aud bowlders, and sometimes of gravel and sands.

Prehistoric Traps.—Some curious wooden machines fished up from European peat-bogs were described by Dr. Robert Munro, in the British Association, as probably prehistoric otter and beaver traps. Two of them, which were taken as typical, were found in the great Laybach Moor, in the vicinity of the famous group of lake-dwellings there under investigation. The more perfect of the two was made of a solid piece of oak thirty-two inches long, twelve inches wide, and four inches thick. It tapered a little at both ends, and contained a rectangular hole in the middle, nine inches long and five inches wide, for a valve, which was worked by pivots projecting into corresponding holes in the framework. The valves were freely movable when pushed upward, but the motion was arrested a little short of the perpendicular by the slanting shape of their after-edges, so that when left to themselves they always fell down, and so closed the aperture. Somewhat similar machines have been found in Ireland, north Germany, Styria, and Italy, and their character has been the subject of discussion. They are usually regarded as traps, and it is remarked that all the examples from Italy, Ireland, and Laybach were found in bogs which in earlier times were lakes. If they were really traps, they could be used only in water, where the animal could insert its head from below; and, among amphibious animals, the otter and beaver are the only ones to which all the conditions involved in a trap theory would apply.

The Qualifications of a Good Nurse.—"Now in what," asks Dr. Hal C. Wyman, in an essay on The Training of Nurses, "shall the ideal nurse be trained? She should have a good education. She need not be schooled in mathematics or philosophy, poetry or science; but she must have a good common-school education that will enable her to read any instructions that may be given her, or left with her, in writing; to make records of the condition of the patient, and to write orders for those who may be subject to her. . . . She must be fully acquainted with the English and the metrical system of weights and measures, and she ought to be a good reader, sufficiently well acquainted with the art of elocution to read various selections for the entertainment of her patient. One of the most interesting scenes of hospital life I ever witnessed was that of a Gray Nun in a ward of paralytic and demented patients, reading the news of the day. The soft modulations of her voice, the rapt attention of her listeners, and the agreeable contrast to the listless, weary air of the patients in an adjoining ward I shall never forget." Not only should there be trained nurses in large cities and in connection with large hospitals, but they are needed "in communities where there are no large hospitals, in communities where there are no hospitals at all, and there ought to be some means of training them on the ground where they are needed. Every county, nearly, has its organization for the medical care of the sick poor. That class, more frequently than any other, needs the tender and supporting ministrations of the nurse. Why not, wherever there are physicians employed by the county, have the county physician, with the aid of the superintendents of the poor, organize a school for the training of nurses?"

Reversion, or Arrested Development.—In a paper in opposition to the doctrine of reversion to a former type, Miss Layard said, in the British Association, that in considering the subject of linear evolution the great importance of a clear understanding of the laws of reversion is apparent; for, if it can be positively proved that structures common to lower groups occasionally make their appearance in man through this means, a strong point has been gained. It is logically certain that there can not be a return to a state which has not once existed. But if, on the other hand, such appearances can be traced to an arrest during the process of development, or to a sport, the phenomenon shows no connection between higher and lower groups. If we carefully divide positive cases of arrested development and sports from those which may be, strictly speaking, considered to have true appearances of reversion, the number diminishes enormously. Perhaps the most important point to be ascertained is as to the limit of time after which reversion to an earlier type becomes impossible. If there be no limit, then it may be a matter of surprise that reversion is not more constant in man.

Storage Reservoirs for the Mississippi.—Captain Eads's scheme of jetties and all other plans for improving the Mississippi River by tinkering with the channel are condemned by Mr. Jacques W. Redway, in a pamphlet on The Physical Geography of the Mississippi River, as likely to work more mischief in the end than they remedy. The author, on the other hand, advocates a plan embodying the storage of the surplus water that accumulates during the spring floods. This will both lessen the volume of the freshets that occur at the breaking up of the winter season, and also furnish a supply to be drawn from during the low stage of summer and fall. The storage reservoirs in construction at the present time are mainly the natural basins at the head of the Mississippi proper—Chippewa, St. Croix, Crow Wing, and Wisconsin Rivers. To hold the water subject to control, a dam is to be constructed across the lowest rim of each basin—that is, that part of the rim which is the drainage outlet of the basin. In each case the discharge gate of the reservoir will have an area not less than the cross-section of the stream at low water. It is shown that 95,572,000,000 cubic feet of water may be stored away in the reservoirs on the Mississippi alone. The reservoirs already completed on that stream show an actual capacity of nearly 5,000,000,000 cubic feet more than their estimated capacity. Not all of this water is available for storage, however, as 46,000,000,000 cubic feet are required for the constant flow between May and December, leaving a minimum of 49,000,000,000 cubic feet (with a possible ten per cent more) available for storage. Calculations show that with a low stage of water continuing for four months, the amount to be drawn from the reservoirs would aggregate only 42,000,000,000 cubic feet against an actual amount of 49,000,000,000 cubic feet in the reservoirs. This, if we consider the increased actual over the estimated capacity of the reservoirs, would give 5,800 cubic feet per second that could be spared, while only 4,400 are needed. Including also the reservoirs that might be constructed on the Wisconsin, Chippewa, Crow Wing, and Fox Rivers, the available supply could be increased to a possible 40,500 cubic feet per second for ninety days. The reservoirs, once they are constructed at the sources of these streams, will give a much more uniform volume in the Mississippi, so as to insure a fair stage on all bars, and will also add several hundred miles of navigable waters to the great system of river transportation. These streams are mentioned, not because they are more important than the large rivers below, but because they are the outlets of hundreds of large lakes in the northern part of Minnesota and Wisconsin. Their freshets may be an important factor in the more disastrous floods of the lower Mississippi.

Glacial Action in Niagara River.—Prof. G. W. Halley dissents from Prof. Gilbert's theory of the history of Niagara River, and believes that glacial action was an agent in the formation of the channel. In 1840, he said, a large surface of rock on the bank of the river was removed at different points for the purpose of making certain improvements, and was found to be deeply scored, while the vicinity furnished many granite bowlders. Three branches of drift stone and gravel are developed at Lewiston, and the evidence of glacial action is abundant. These and other facts which the author mentioned point, in his opinion, to the existence and progress of a grand terminal moraine, which was once the boundary of an immense inland sea. So far from the Niagara River carrying no sediment, as Prof. Gilbert assumes, and as one who visits it in summer might be justified in supposing, one who lives near it many years may see its waters running for ten days at a time with a dirty chocolate or dark amber color, and charged with great quantities of sand, gravel, and silt; and could hear in the rapids the gravel and pebbles grinding and scratching their way along the rough bottom. The vast dense bar at the mouth of the river on Lake Ontario is overwhelming proof of its immense scouring properties.

Value of Science in Industries.—In his paper on The Development of the Coal-tar Color Industry since 1880, Dr. W. H. Perkin named various coloring matters which had been discovered during the last ten years, and illustrated his remarks by experiments with different colors. Germany still holds the first position in the market, both as to quality and quantity, but the competition of Swiss, French, and English manufacturers with that country has been steadily increasing. Several years ago the author had expressed an opinion of the necessity of scientific research being made an important part of the training for chemical students, so that highly skillful chemical men imbued with a spirit of investigation might be produced, not only to fill chemical chairs, but also to occupy important positions in chemical works. Hitherto not so much progress had been made in this direction as was desirable, and he feared that this was to some extent due to manufacturers not having as a body sufficiently realized the great importance of employing such men in their works. Thus, the demand being small, the supply necessarily corresponded; but surely the wonderful development of the coal-tar industry, which had been and still was being carried on in such thoroughly scientific spirit, was an example which should not be forgotten. Sir Frederick Abel, the President of the British Association, where the paper was read, was struck with Dr. Perkin's remarks on the reasons why the English had been left behind in the development of that particular industry, and said that there were now great works in Germany where chemical research is carried on as an elaborate business, and was pursued by men who had acquired university degrees and distinction. He knew of one establishment where forty trained chemists were at work on the particular branch of research in which it is interested. If they could get a small army of men in England to pursue the work systematically, they might regain lost ground. In the first years of the coal-tar industry the English claimed it as particularly their own, but now they could not do so in view of the competition of the French and Germans.

The Available Lands of the Globe.—The subject of the lands of the globe still available for European settlement was discussed at a joint meeting of the Geographical and Economical Science Sections of the British Association. Mr. G. E. Ravenstein reviewed the capacity of different parts of the earth, excluding the arctic and antarctic regions as wholly unavailable, to accommodate population. He estimated the total number of persons whom the earth could feed at 5,999,000,000. The kind of population with which it shall be inhabited will depend to a large extent on the capacity of Europeans to thrive in strange climates. He spoke of the tendency of populations to move to the southward, but did not think tropical climates adapted to the acclimatization of European races in the sense in which the word acclimatization is generally used. The health of Europeans in tropical countries had improved in consequence of sanitary measures, but that was not all. Population in some countries did not increase; and, where they could compare the facts collected in the same country, they found that the superior race increased at a slower rate than the inferior race. That would, in course of time, keep back the growth of population, and, in fact, the whole of mankind was being gradually lifted up to a higher level. If only the superior, not the inferior, people increased, the speaker did not think the progress of civilization would be quite so steady. Mr. E. J. Marend, after his experience in Africa, was of the opinion that the prevalent idea that tropical regions are unsuited to colonization by Anglo-Saxons is mistaken. Englishmen live for years in Matabeleland, bringing up their children and keeping their health. Traders, missionaries, and Dutchmen are all able to thrive there, and the country is competent to provide the food-supplies for a large population. Sir R. Rawson believed that the proportion of land in the different zones is as follows: About fifty per cent of the whole is in the temperate zone, about forty per cent in the torrid zone, and about a tenth in the arctic zone. Before going further in dealing with a future home for the surplus population of Europe, we must ascertain the zones that are suited to a European population. The surplus population of England and the north of Europe could occupy only a temperate zone. It was also essential that we should know how much is available in each of the zones. Mr. John Mackenzie's experience had shown him that South Africa is habitable for both the north and south Europeans. The Rev. Dr. Cunningham pointed out that the intensity of production might be much increased through the direction of native agriculture by European intelligence. Mr. Wells, a traveler in Brazil, from whose papers we have quoted, called attention to an area in the south of that country which might be called the Transvaal of South America. To the northwest of Rio lay a considerable coffee-producing area, with an exceedingly healthy climate, and the productive powers of the country were very far indeed from being approximately reached. Several speakers mentioned the necessity of emigrants to the south adapting their mode of life to the changed climate, and insisted on the necessity of temperance. Dr. J. G. Garson said the question of drainage was most important, though it often occurs that the first steps toward sanitation are followed by outbreaks of fever, arising from saturation of the soil by sewage. Elevation above the sea-level exerted much influence on health, though the great thing for emigrants was to choose a climate as nearly as possible like that to which they were used.

An Experiment in Hypnotism.—Mr. A. Taylor Inness contributes to the London Spectator a curious relation of a case in which a hypnotizing practitioner ventured to stop the beating of the heart of his subject. Calling a physician of the place, who was well acquainted with the subject, to himself, he asked him, "Doctor, will you put your finger upon his left pulse, while I keep mine on his right?" Dr. ——, says the story, "was skeptical and hostile, but at our instance he consented. Keeping one hand on the lad's wrist, Lewis laid the other gently over his heart. Within a minute or two M. —— lost his rich and vivid color, and Lewis counted the decreasing strokes till he announced that they were scarcely recognizable. 'Is that not so, doctor?' he asked. Dr. —— was extremely unwilling to speak; but, under the urgency of some of us who stood by, he at last said, in so many words, that the pulse had almost shrunk to nothing. The boy stood, a ghastly statue, for a minute longer, when Lewis, saying hurriedly, 'The pulse is now imperceptible; we must protract this no longer,' took away his hand from the breast, to the evident relief of his improvised colleague. But it was to the evident relief, too, of their common patient. I remember distinctly to this day the ashen hue even of his lips, and the wonderful gradations through which the blood found its way back into them and into the whole young face—a face still asleep, but now glowing as if it had traveled a long way from the margin of the grave."

Physical Geography of the Mediterranean.—Sir R. L. Playfair said on this subject, in his British Association address, that the Mediterranean must at one time have consisted of two inclosed or inland basins like the Dead Sea, separated by the isthmus between Cape Bon, in Tunisia, and Sicily. The depth between Italy and Sicily is insignificant, and Malta is a continuation of Sicily. The shallows cut off the two basins from all but superficial communication. The configuration of the bottom shows that the whole strait was at one time continuous land, affording free communication for land animals between Africa and Europe. In the caves and fissures of Malta are three species of fossil elephants, a hippopotamus, a gigantic dormouse, and other animals that could never have lived on so small an island. In Sicily remains of the existing elephant have been found, as well as the *Elephas antiquus*, and two species of hippopotamus, while nearly all these and many other animals of African type have been found in the Pliocene deposits and caverns of the Atlantic region. The submersion of this isthmus no doubt occurred when the waters of the Atlantic were introduced through the Strait of Gibraltar. The rainfall over the entire area of the Mediterranean is not more than thirty inches, while the evaporation is twice as great. Therefore, were the strait to be closed, the level of the sea would sink again, and this would affect the Adriatic and the Ægean Seas and a great part of the western basin. At the Strait of Gibraltar an upper current at three miles an hour supplies the sea with the difference between rainfall and evaporation. An opposite current of warmer water flows out at half the rate, carrying off the excess of salinity, but leaving the Mediterranean salter than any part of the ocean except the Red Sea. The almost constant temperature of 56°, compared with 53° to 49° in the Atlantic, enabled Dr. Carpenter to distinguish between Atlantic and Mediterranean water.

Customary Survivals.—Our knowledge of primitive civilization, says Canon Isaac Taylor, in Knowledge, is largely derived from the study of survivals. Survivals may be defined as anomalous traditional usages, seemingly meaningless or useless, which originated in some state of things that has passed away, but which by the force of custom have continued to exist. That the Queen still gives her assent to acts of Parliament in a formula couched in Norman French is, for instance, a survival from the time when the sovereign of England was a Norman duke, unable to speak English. A judge's wig is a survival of the long hair which came in fashion at the Restoration; and the black patch on the crown, with its white fringe, is a survival of the black skull-cap that was worn over the coif of white silk or linen that formed the head-dress of the sergeants-at-law from whom the judges were selected. The procurations paid to an archdeacon of the Church of England are a money composition in lieu of his ancient right of quartering himself and his attendant horsemen on the parochial clergy during his visitations. Fee-farm rents, as they are called, are in many cases survivals of payments for services no longer rendered. Canon Taylor pays a rent of this kind, which represents a composition for a certain number of thraves or sheaves of corn, which his predecessors in title rendered to the Abbot of Beverley for his services in "correcting the villans" of a certain parish, who might avail themselves of the privilege of sanctuary that was conferred by Athelstan on the monks. The unchronicled history of English villages may be largely recovered from the study of such anomalous survivals. Sir Henry Maine and Mr. Seebohm in England, and Von Maurer and Prof. Nasse in Germany, have made some valuable researches in this line, and Mr. G. L. Gomme has added to them. The last author explains a duplicate municipal jurisdiction that used to prevail at Rochester by assuming that there was a community there of Danish origin, governed by its own laws and officers, but subordinate to the rule of the Saxon community. Canon Taylor also cites a more striking case at Exeter, where Mr. Kerslake has succeeded in delimitating the boundaries of the Celtic and Saxon communities which dwelt side by side within the walls.

Early Printing at Avignon.—Documents have been recently discovered by the Abbé Requin that go to show that printing was practiced at Avignon before Gutenberg introduced it in Mentz. They record that in 1444 one Procopius Valdfoghel (Waldvogel), a goldsmith of Prague, was living at Avignon, and instructed two students there—Manaud Vitalis and Arnaud de Coselhac—in the art of artificial writing and furnished them with the instruments for it, consisting of two abecedaria of metal and two iron *formæ*, a steel screw, forty-eight *formæ* of tin, and other implements. About the same time Valdfoghel instructed one Davin, of Caderousse, a Jew, in the same art; and two years later, on the 10th of March, 1446, he entered into an agreement with the Jew to supply him with twenty-seven Hebrew letters cut in iron, and other implements for the practice of printing. At the same time the Jew agreed not to disclose the art, either in theory or practice, to any one as long as Valdfoghel remained at Avignon or in the neighborhood. A partnership was formed between Valdfoghel and his two former students, from which Vitalis retired in April, 1446, giving up his share in the implements, whether of iron, steel, copper, lead, and other metals, or of wood. He also made oath on the Holy Gospels that the art of artificial writing taught him by Valdfoghel was a true art, and easy and useful to any one who desired to work at it and was fond of it. It is questioned whether this declaration was obtained to avoid the imputation of sorcery, or to commit Vitalis to an assertion that the invention was a successful one. These transactions took place while Gutenberg was still experimenting at Strasburg, and their date, if confirmed, would fix Avignon, instead of Mentz, as the second city where printing was carried on.

Sparrows and Robins.—Another attack on the English sparrow is made by C. B. Cook in a Bulletin of the Michigan Agricultural Experiment Station. No new charge is made against the sparrows, nor is any new proof adduced of the old charges that when too numerous they are a nuisance and that they drive away other birds. We respect, if we do not love them, for the good they have done in clearing city trees of measuring-worms. As to their incompatibility with other birds, we have the witness of one suburb of New York, where the sparrows have been the longest and have multiplied the most, that since the law came in to protect other birds against the man with a gun and the boy with a stone, the robins have been increasing very fast, are not troubled by the sparrows, and during the past spring were more often seen than they. Thus the assertion that man, not sparrows, is responsible for the recent scarcity of song and friendly birds is confirmed. Mr. Cook's paper furnishes an amusing if not pleasant illustration of the folly of offering bounties for the destruction of sparrows.

Nearly five hundred dollars were paid out in Michigan from July, 1889, to March, 1890, "for 15,697 sparrow-heads." Most of the birds, Mr. Cook says, were red-polled linnets —valuable birds. It would perhaps be better to protect the good birds more efficiently and not worry so much about the sparrows. That plan has had excellent results in New Jersey.

Permanency of the Earth's Features.—A paper was read in the American Geological Society by Prof. E. W. Claypole, traversing the doctrine toward which a few geologists are tending, that the sea-beds and the continental masses are permanent and date back to the original consolidation of the earth's crust. After reviewing the several arguments by which this theory is supported, the author concluded that "we have ample evidence of change of level to account for the conversion of the deep sea into dry land and *vice versa*, and that the absence of deep-sea deposits among the stratified rocks is not a valid objection. It would also follow that the depression may occur in any part of the world according to laws as yet unknown, but that when a depression is full of sediment re-elevation is likely to occur; that the deep ocean-beds, instead of being permanent outlines of the earth's contour, are subject to the same laws of elevation that govern the rest of nature. On this view the ocean abysses would be areas of subsidence unfilled by deposit because they were out of the reach of shore action, rather than permanent depressions on the earth's surface."

Democracy and the Churches.—The Influence of Democracy on Religion is the subject of an article in the London Spectator, suggested by the popular enthusiasm aroused by the funeral of Mrs. Booth, of the Salvation Army. The author accepts the story of the Salvation Army, and the story of the Wesleyan movement of the last century, as testimony to the unconscious influence of democratic feeling on ecclesiastical organization; and he believes that the whole character of the Reformation and its offshoots has been gravely affected by the attraction of democratic forms and phases of feeling for religious natures. Both Judaism and Christianity have always placed the poor, and especially the poor in spirit, above those accounted the possessors of this world's privileges; and, as a consequence, these religions have struck at the heart of slavery, and have raised women to the spiritual level of men. The earlier Protestant enthusiasm may have profited by the democratic aversion to specially privileged spiritual orders, like the priesthood and the episcopate. The recognition by the Wesleyans of the ministerial capacity of the laity, and the jealousy against a hierarchy manifested by many other of the Nonconformist churches, gave the religious world a consciousness of the popular advantage which a more emphatic development of the democratic idea in religion bestowed on those churches and sects which were founded on free choice by the laity of their ecclesiastical representatives. The Nonconformists have been compensated for their rejection of state privileges by being brought thereby nearer to the people. The influence of democratic tendencies in other churches is also marked. The universal tendency in Ireland, where the priesthood are of the class which feels most keenly the pressure of democratic principles, to modify and even defy the authority of the Roman Catholic Church in the interest of the peasantry, has been very startling. In England the Episcopal churches, both Anglican and Roman Catholic, are curiously divided between the strong democratic sympathies which their rulers feel under the pressure of public opinion and the natural leaning of their theology against anything like concession to the lawless cravings of the human heart. Roman Catholic dignitaries in England express their sympathy with Irish offenders against the law and with recalcitrant bishops in Ireland. Church congresses discuss social reforms with a disposition to find a middle ground between the old principle of individual right and liberty and the new collectivism. In the United States even Roman Catholic priests take part with the Knights of Labor and ignore the authority of their bishops. English Roman Catholics support earnestly movements known to be popular, and when there is a struggle between labor and capital the greatest man is on the side of labor, often when labor is in the wrong. Everywhere the spread of democracy is redressing, and more than redresses the balance of religious prepossession. Yet it is certain that no religion will remain popular long which does not put a strong curb on the passions and whims of human nature. This, too, is felt, and the course of ecclesiastics is modified by the feeling.

Shorter Hours and Wages.—An elaborate review of the probable effects on wages of a general reduction in the hours of labor, presented in the British Association by Prof. J. E. C. Munro, brought him to the following conclusions: 1. A reduction in the hours of labor which is neither universal nor uniform will tend to reduce the net product available for division among the producing classes, but such reduction may be lessened or counteracted by greater efficiency in labor and in the use of capital. 2. Capital will be able to throw a portion of the loss on labor, and labor generally will be affected. 3. Any check to the accumulation of capital due to the reduction in the net produce will tend to raise interest and lower wages; but this may be avoided to some extent by the more economic use of capital. 4. The reduction in hours will not necessarily lessen the number of the unemployed, inasmuch as it will not increase the purchasing power of the consumer, and will not affect the chief cause of poverty incident to our present organization of industry. 5. The position of the chronic unemployed, or residuum, will not be materially improved. 6. In so far as additional laborers are employed to maintain the net produce, it will be at the expense of other workers, if the net produce remains the same but the number of producers increases. It is necessary to point out, the author added, that arguments which may be urged against a general, though unequal, reduction of hours do not apply with the same force to a reduction of hours in a particular trade that may be the subject of special economic surroundings. Before venturing to express an opinion on the desirability of reducing hours in a given industry—mining, for example—the economist will require to investigate these surroundings in order to estimate what loss, if any, will occur, and upon whom such loss will fall. But, even if there be a loss in a particular industry or a national loss, it may be more than made good to the nation by the beneficial effects on the working classes of greater leisure. Hence the importance of asking what the working classes will do with the hours they gain from toil. Reasons drawn from current movements were given for believing it probable that, so far as the skilled industries are concerned, the workers would, on the whole, utilize additional leisure in a manner creditable to themselves and useful to the state. Prof. A. T. Hadley, of Yale College, in the discussion of this paper, cited the results of an investigation which was made ten years ago into the relative output of ten-hour workmen in factories in Massachusetts and eleven-hour men in Connecticut. The result was in favor of ten hours in Massachusetts, and was proved not to be owing to any difference in the health of the workmen, but largely to the fact that the workmen of the Massachusetts mills were of a superior class to those of Connecticut. There was a process of a sort of natural selection going on among those who did not mind the long day and could not stand the increased pace of the short day, and those who cared more for the extra hour of leisure and minded less the necessity of increased exertion.

Fast and Fugitive Coal-tar Colors.—In a paper on fast and fugitive coal-tar colors Prof. J. J. Hummel, in the British Association, contradicted the idea that the modern coal-tar colors are all fugitive while the colors of the older vegetable dye-stuffs are all fast. There are fast and fugitive dyes in both classes. We have now about five hundred distinct kinds of coal-tar colors, of which about thirty are extremely fast and an equal number or more are moderately fast. On the other hand, out of the thirty or so natural dye-stuffs usually employed we count ten as giving fast colors. We have, therefore, a total of about three times as many fast coal-tar colors as of fast natural dye-stuffs. This pitting of natural as against artificial coloring matters ought now to cease. Of course, it is not to be denied that we have a very large number of fugitive coal-tar dyes; and the indiscriminate use of these, due largely to competition, has, no doubt, injured the reputation of the whole class. The question, often asked, whether there is no method of rendering the fugitive colors fast, must be answered in the negative. The fast or fugitive character of a color is an inherent property of the coloring matter used, and depends mainly, if not entirely, upon its chemical constitution. In order to improve the fastness of coal-tar colors we should examine thoroughly the characteristic of every coloring matter, then choose the fastest and reject the rest, or only employ them when they are perfectly admissible. Such a process of selecting the fittest has gone on in the past with reference to the dye-woods, and such is the sifting process now at work among the coal-tar colors. Side by side with this must run the selection of the most brilliant and most easily applied of the fast colors, so that the ultimate goal of perfection to which we would thus attain would be to have all our colors fast, brilliant, and easily applied. Given a good range of brilliant colors, it becomes possible by their varied combinations to produce the most peculiar, pleasing, and attractive shades of grays and olives and browns, and the thousand and one delicate tints beloved by the artist; and they yield when desired a richness and life and body of color compared with which older colors are poor and lifeless. Let the artist, inexperienced perhaps in the application and proper use of coal-tar colors, confine his attention, if he wishes, to the more somber and older dye-stuffs, but do not allow him to persuade you that there is no beauty or permanence or other quality of excellence in any of the coal-tar colors of to-day.

NOTES.

PROF. F. V. RILEY takes a hopeful view of the promise of good results to come in apiculture from experiment and investigation. He pointed out, in his address last fall before the Society of Economic Entomologists, as one of the most inviting fields the search for new varieties or species of bees and their introduction; "for just as American apiculture has profited in the past by the importation of races like the Italians, Syrians, and Carniolans, there is every prospect of further improvement by the study and introduction of such promising races as are either known to occur or may be found in parts of Africa and Asia." The further study of desirable bee forage plants, and the introduction and acclimatization of such as are known to be valuable to parts of the country where they do not yet occur, are very desirable.

A NEW spice adulterant is described by Frank A. Hennesey, Ph. G., in The Pharmaceutical Era. It consists of ground crackers made from a very low grade of wheat—but little better than cattle-feed. The powder thus obtained is colored yellow with turmeric, black with charcoal, brown with Spanish brown and turmeric, etc., according to the spice it is to adulterate. The biscuits are made in a steam bakery in Philadelphia, and large quantities of them have been delivered to a certain spice house in the same city. The presence of this adulterant can not be detected except by a chemical analysis of some difficulty. Ordinary cracker dust has also been used for this purpose.

A CORRESPONDENT of La Nature, from Bagdad, describes a shower of rain accompanied by a fall of "manna," that took place in August, 1890, around Mardeen and Diarbekir. A surface about ten kilometres in circumference was visited. The nutritious substance was picked up by the people and made by some of them into bread, which had a pleasant taste and was easily digested. A specimen of it sent to La Nature was in the form of spherules, about as large as millet-seed, agglutinated together; was yellowish on the outside and white within. It proved, after a botanical examination, to be a lichen (*Lecanora esculenta*), which, according to Decaisne, is common in the arid mountainous regions of the Tartarian desert, where it lies on the ground, distinguishable only by the most practiced eyes from the gravel with which it is mingled. Parrot told, in 1828, of a shower of it which fell in Persia, where it was collected by the people and was greedily eaten by cattle. The particles had probably been taken up by some whirlwind and separated from the accompanying sand while passing through the atmosphere.

A BOLD device, which will also furnish a new source of excitement, is suggested by M. Aristide Berges, a French engineer, in the shape of an elevator-car to fall, with its passengers, through a thousand feet, or the height of the Eiffel Tower. During its fall the machine will acquire a velocity of about 250 feet per second, or more than twice that of the swiftest express train. The car will be built in the form of a long cone, strengthened by inner cones which will act to prevent the sudden compression of the air within the chamber, and will be about thirty feet high. To break its fall, a well of water will be provided, 160 feet deep, into which the machine will descend, and sink so gradually as to remove the sensation of shock. A picture is published by the designer showing the car carrying fifteen people in its headlong journey.

A unique collection of migrating birds formed at Heligoland during forty years by Herr Gätke has been bought for England by Mr. Henry Sebohm, and is to be deposited in the natural history department of the British Museum.

Observations made on Venus to test the conclusions of M. Schiaparelli respecting its rotation, indicate that the rotation is slow, and is made in such a way that the relative position of the spots and terminator do not go through any notable change during many days; that the time of rotation of the planet does not differ more than thirty days from its sidereal period of revolution (about 225 days); and that the axis of rotation of the planet is almost perpendicular to the plane of its orbit. These conclusions support those deduced by Schiaparelli from an extended discussion of all the observations of the planet.

A curious instance of protective mimicry in a toad is described by Mr. Robert Snordy, of Durham, England. The muscles of the batrachian's body were (as usual) arranged in such a fashion that the back of its head "looked like minute nodules of dark gravel imbedded in a damp path below trees." On top of this gravel-like arrangement of muscles was spread a mesh or network of very fine lichen, with oval-shaped leaves of lightish-green color, connected more or less to each other by a hair-like process of stems. This lichen spread irregularly over the toad's back, and odd sprays of it were also to be seen on the legs and upper surfaces of the feet. "Now," says Mr. Snordy, "had the toad been in its regular haunts under t e trees and shrubs, with this wonderful counterfeit of gravel and protective coloring, it would have been almost impossible to discriminate its form from the dark gravel, lichens, moss, wood, sorrel, and dead leaves of the place; and I doubt not that this animal's unobtrusive attire would aid it materially in capturing the insects necessary for its subsistence."

In Paris compressed air is supplied to houses through pipes for working elevators, and also for refrigerating purposes.

An Edinburgh physician writes to the London Times that he has driven a horse, without shoes, on a tour of over four hundred miles, and afterward used him on paved and macadamized streets, without the animal showing any signs of lameness or tenderness. With two larger horses the experiment failed. In slippery weather the unshod horse proves far more sure-footed than a horse with roughened shoes. The doctor concludes that where the growth of the hoofs is strong and rapid, horses are the better for not being shod, especially in the country. The front of the hoofs may have to be rasped away a little, but the sole of the foot is left untouched.

The ratio of the circumference to the diameter of the circle was calculated by Archimedes as 22 : 7; P. Metius made it 355 : 113. Now Shanks has fixed it, after a very long calculation, as far as 530 decimals, and Rutherford has verified his results up to the 440th decimal. Omitting the integer and taking only the fractional part of π, in the decimal notation, he has found that the first twenty figures added together give 100; the alternate figures in the odd series (first, third, etc.) give 45; and the alternates of the even series (second, fourth, etc.) give 55. A curious triple coincidence, but one that has no meaning.

A number of experiments on the comparative palatability of insects, etc., are recorded in Nature, by E. B. Tichener and F. Finn. The insects experimented upon—consisting of beetles, moths, bees, etc.—were offered to domestic mice, common toads, and a common mynah (*Acridotheres tristis*). The results evinced considerable variability and some caprice in the tastes of the animals fed, but do not indicate that their appetites were voracious for the delicacies given them. The stronger beetles were taken with some hesitation. The mice declined to take bumble-bees; the mynah ate wasps greedily; the toads readily took wasps and bees, and were often stung, without seeming to pay much attention to the accident. The cockroach was eaten by the toads. The mynah for a long time refused it, and only took it, as well as the earthworm, finally, in the dearth of other insects. A few centipeds were given to the mice and the mynah, but were never eaten, though the mice, in one case, eagerly seized and killed a large specimen.

A striking example of law-making defeating its own purpose is furnished in India, where a bounty offered for killing poisonous serpents has led the natives to breed the reptiles as a source of income. This recalls a former practice in Australia, where a reward was paid in one district for the feet of rabbits, and in another district for their heads. As a result the heads and feet became objects of exchange between the inhabitants of the two sections.

An instance of transmission of an acquired mental peculiarity is given by Pastor Handtmann, of Seedorf on the Elbe, to the German Anthropological Society. It occurred in the case of a farmer who always wrote his first name "Austug" instead of "August," and his daughter. Inspecting the school, some years after his first acquaintance with it, the author heard a little girl read "Leneb" for "Leben," "Naled" for "Nadel," etc. She was the daughter. The farmer had been remarkable for his habit of shifting the consonant sounds of words, which had originated in a fall some time before the birth of the daughter.

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